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REPORT

OF

THE SPECIAL COMMITTEE,

APPOINTED BY THE LAST LEGISLATURE TO REPORT ON THE BEST METHOD OF OBTAINING A COMPLETE

GEOLOGICAL SURVEY

OF

THE STATE OF OHIO.

COLUMBUS:

JAMES B. GARDINER, PRINTER TO THE STATE.

1836.

REPORT

To his Excellency, Robert Lucas,
Governor of Ohio:

The undersigned, having been appointed a Committee, under a resolution of the Honorable Legislature of the State of Ohio, passed the 14th day of March, A. D. 1836, "to report to the next Legislature the best method of obtaining a complete Geological survey of the State, and an estimate of the probable cost of the same," have had the said resolution under consideration, and report as follows:

In making any thing like a satisfactory report on so important a subject, as a Geological survey of a great territory like that of Ohio—embracing a variety of soils, and such various aspects of surface, your Committee were persuaded it would be necessary for them to visit, in person, the most interesting districts for valuable minerals and fossils; especially those portions known to abound in iron ores, coal, and salt; the three main staples on which the future millions of Ohio must depend for their manufacturing wealth and greatness.—Far removed from the shores of the ocean, and precluded from partaking in foreign commerce, that boundless mean of riches to the Atlantic states, Ohio must depend on her own resources, and seek, within her own bosom, for the supports of independence. Her luxuriant and exhaustless soil—capable of yielding bread-stuffs in greater quantities than ancient Egypt—with cattle, wool, and the productions of the dairy equal to those of any other land, possesses, in addition to all these, inexhaustable riches yet hidden in the bowels of the earth. And although the surface is yielding millions to the plough-share, that below the surface is capable of furnishing still more numerous millions.

From the fact that Ohio possesses no elevated ranges of mountains, we should at first sight be led to conclude that her rock strata contained few or no minerals; and it was in fact for many years after its first settlement, supposed that the inhabitants would be always dependent, as they then were, on the Atlantic states for the two great and indispensable articles to an agricultural people, salt and iron. But as the country became cultivated, and its resources more developed, it was found that these two commodities were amongst the most abundant productions of the region skirting the western declivities of the Alleghany ranges. The valley of the Ohio, from the mouth of the Scioto river to the country above Pittsburgh, is composed of alternate strata of sand rocks, lime stone, bituminous coal, iron ores and shales, resting on a stratum containing muriate of soda, or marine salt; and extending to an unknown depth. From its vast extent, we are led to conclude that it is deposited in exhaustless quantities. These several series of strata were originally deposited in nearly horizontal beds; but subsequently raised into mountain ranges on

the east, and south east borders of the valley; and into table lands, west and north of the sand stone rocks in Ohio and Pennsylvania. Through the most depending portion of this valley, the Ohio river now slowly and calmly winds its way, skirted by hills of an elevation of from two hundred to three hundred and fifty feet. These hills, at some remote period, were doutless united in continuous strata; from the well known fact, that beds of coal, iron ore, sand rocks, &c., found at a certain elevation in the hills, on the right bank of the river, are also found at the same elevation, on the left bank; demonstrating that the present hills were formed by the wasting away, in the course of ages, from rains, floods, and frosts, of the intermediate rocks and earths; and leaving the residue of the strata in their present form of hills, valleys, and deep ravines. This wasting of the strata, has not only completely drained the country of the waters which once covered it, and fitted it for cultivation and the residence of man, but has also brought to light, under very favorable circumstances, the different strata of coal and iron ores, that would otherwise have been concealed beneath the surface of the earth. This hilly, broken region, so lightly esteemed by the agriculturalist, has been wisely prepared by the Creator, in the most convenient and accommodating manner, for the comfort and happiness of man; the coal and iron being so placed by the wasting away of the original strata, as to be accessible with the least possible labor and expense—while we have every reason for believing that still thicker and more rich deposites of mineral coal and iron ore are placed deeper in the earth, to reward the industry, and supply the wants of man, when this valley shall be thickly populated, and the wealth of the country adequate to the expense of deep, underground mining, such as is at present practised in Germany and Great Britain.

With the view of ascertaining what the State really afforded in its mineral capacity—in order to render it desirable that a Geological survey should be made, the Committee have personally visited some of the most interesting portions, and particularly ascertained, from intelligent individuals, the resources of such parts as they could not examine themselves.

IRON ORE DEPOSITES.

Commencing, then, with the iron ore beds of Scioto and Lawrence counties, as paramount in importance to that of any other mineral deposites in the state, we find the main beds commencing about fourteen miles above Portsmouth, near the Ohio river, where the ore is seen cropping out on the tops and sides of the hills; and was first brought into use about the year 1828. The combined series of minerals, here associated, is so interesting, and their present and future importance so vast and influential on the wealth and greatness of the state, that the committee have thought it best to attach a diagram, illustrating animaginary section of the region, extending from the mouth of the Scioto to Ice creek, a point between Burlington and Hanging-rock. It commences with the lowest bed of iron ore, resting on a fine grained sand stone, which underlies all this region; extending far up the Scioto to Waverly, and bearing off north easterly, across the counties of Fairfield and Licking; coming occasionally to the surface, but lying under the coarser sand rocks, which are alternately with the iron and coal of the hilly parts of the state. We shall refer to this rock again, in another place.

These several deposites of iron ores, extending to six or more distinct beds, lie at an inclination of about thirty feet to the mile, dipping to the east, south east; and are seen, as we travel easterly, cropping out at successive, but irregular intervals, on the surface of the highest hills, at a few miles back from the river, and gradually sinking deeper in the earth,

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are finally lost at the base of the hills, disappearing beneath the beds of the streams. The diagram will illustrate the descriptions which follow, and is true, as it relates to the order of superposition, or succession of the different strata.

Commencing, then, with ore bed No. one, we find it at the Franklin furnace, in Scioto county, sixteen miles above Portsmouth, resting on the main, fine grained sand rock, at an elevation of one hundred feet above the bed of the Ohio river. The hills here are estimated to attain an elevation of three hundred feet. It is a porous silicious ore, two feet in thickness, resembling, in external appearance, that variety called "Bog-ore;" and is probably the same deposite which is found on the west side of the Scioto river, in Adams county, and worked at the steam and marble furnaces. It is not at present in use at this place, from the circumstance of a much richer ore being found here in abundance. It will however, without doubt, be brought into use at a future day. Its comparative value, as a workable ore, may be seen in the appendix, with the analysis of the several ores, where it is found to afford —— per cent. of iron.

Reposing on ore bed No. one, is found a deposite of sand rock, sixty feet in thickness; the upper portion of which is nearly white, fine grained; and found to be a valuable material in constructing the furnace hearths—sustaining a great degree of heat without fusion or fracture. It often contains imbedded fragments of pure mineral charcoal; rendering it porous when burnt, and in some respects resembling the composition of the portable furnaces in use for culinary purposes; which resist fracture, from the action of heat, by having a portion of saw dust mixed in the composition; this burning out when heated, leaves them to shrink and expand without injury. It is a very valuable material to the furnace holders, as they thus find on the spot, an article which in many places, has to be transported from considerable distances. Resting on the sand rock, is a bed of bituminous coal, from two to three feet in thickness; varying in this respect at different places. It is worked for the purpose of supplying fuel to the steam engines in use at the furnaces, to keep up the blast. The roof of the coal bed is composed of slate and bituminous shale, six feet in thickness. Reposing on the shale, we find a bed of coarse sand rock, containing considerable mica; this bed is about fifty feet in thickness—on this sand rock, lies ore bed No. two. This is also a silicious ore; containing a few fossil shells. It is less porous, and more compact and heavy than No. one. The bed is about twenty inches thick at this spot; and is extensively worked at Darlington's furnace, in Kentucky, four miles westerly from the Franklin furnace. It affords one of the best metals for bar iron, and is remarkably malleable and tough. By those who have made the experiment, it is said to exceed the far-famed Juniata bar iron, in tenacity and strength.

By analysis this ore yields —— per cent. of iron. The roof of this bed is a coarse grained silicious sand rock—which becomes coarser as we approach the summits of the hills, eighty feet in thickness. Resting on the sand rock, is found a deposit of lime stone, wasted and gone, near the surface of the earth, but becoming solid and compact as the stratum descends deeper beneath the rocks. Some miles farther east, it is found to be eight or ten feet in thickness, and filled with fossil shells of a marine origin, whose species and genera are now no longer found living in the Atlantic seas.

Reposing on this deposit of lime stone, is found ore bed No. three—called by the workmen "Block ore," from the fact of its being found in oblong, cubic fragments, nearly continuous, and resembling, when first uncovered, the largest tiles of a brick hearth. This bed is from one to three feet in thickness, composed of two or three layers, when very thick; the upper ones being considerably thinner than the lower or main bed, and

separated by thin layers of slate. It is a rich calcareous ore, abounding in carbon, and affording one of the finest metals for castings; being not only very tough, but also exhibiting a lustrous surface, as if recently coated over with a solution of black lead. Articles manufactured from this ore are very beautiful, and the metal in great demand for stoves, and castings for domestic uses. At the close of each blast, there is found lying on the hearth of the furnace, where this ore is used, a slag of six or eight hundred pounds weight, containing a metal of high specific gravity. Its fracture and metalic lustre is very similar to that of specular oxyde of iron, from the primitive rocks on Lake Champlain, and affords an illustration of the theory that the ores of primitive rocks have once been, and that for a considerable period of time, in a state of fusion. It leaves a streak similar to that of Graphite, or black lead, and soils the fingers when handled. The analysis of this mineral is given in the appendix. The ore No. three, or "Block ore," is a rich calcareous ore, yielding, by the common process of smelting and cold blast, about fifty per cent. of iron. When dug and exposed to the atmesphere, it separates into thin concentric layers, of a rich brown color, and when roasted, preparatory to smelting, it assumes a deep, bright red tint, in some instances approaching the hue of vermillion. It also contains many rare and beautiful casts of fossil shells replaced by the purest ore, and affording an exhaustless supply of specimens for the naturalist, and future students, of organic remains in Ohio. This deposit crowns the summits of the hills, in the vicinity of the Franklin furnace, coming up on to the surface, a few miles northwesterly, and disappears or runs out as we approach within a few miles of the Scioto river—while to the east, and south east, it is found gradually descending to the base of the hills, as high up the Ohio as Storms creek, in Lawrence county, occupying a space of more than ten miles in width, and finally disappearing under the beds of the streams, in a thick deposit, ready to reward the future miners of Ohio, when the surface beds are exhausted. Its extent north easterly is at present unknown; but there are many reasons for believing that this deposit streatches in a broad belt, diagonally across the state, to the vicinity of Lake Erie, or at least as far as the coal measures are found in that direction.

No. four is a thin bed of "kidney ore," in concentric masses, lying from a few inches to a few feet above the "Block ore," in a bed of argillaceous shale; as the two beds descend deeper into the earth, they finally become united into one. The ore also becomes more compact, and changes its brown hue into a dove color, or pale blue. This is doubtless its original tint, but has been changed by gradual oxydation, as the deposit approached the surface of the earth, and became partially exposed to atmospheric influence, from the degradation and wasting away of the superincumbent strata in the long lapse of ages. The same deposit with No. four, or an equivalent one, is believed to be found near Zoar, in Tuscarawas county, and at several intermediate places, as noticed in the American Journal of Science, vol. 31, page 16. The analysis of ore No. four, is given in the appendix.

In progressing easterly with the development of the successive strata, we find reposing on ore bed No. four a coarse grained sand-rock; often containing fossil remains of trees, and vegetable relics, lying in different deposites and beds of variable thickness, the whole amounting to about eighty feet. Resting on the sand stone is another bed of lime stone, eleven feet in thickness. It is a dark colored, compact rock, containing fossi

shells, and affording a suitable material for fluxing the iron ores.—About three miles south east from the Franklin furnace, ore bed No. five, come to the surface, and is found crowning the tops of the adjacent hills. This bed rests immediately on the lime rock, a few miles further east, and deeper in the earth; but at its first cropping out reposes on a bed of silicious rock, much resembling that found in Jackson and Muskingum counties, and is probably a spur or lateral branch of the great silicious deposit, to be noticed hereafter. The deposit of ore is here from three to four feet in thickness, and of a cellular, rough aspect; and is known to the workmen by the name of "rough ore." As it progresses south east, the bed dips deeper into the earth, and changes its aspect to a light dove color, becoming more compact, and requiring to be blasted with gun powder, to separate it from its rocky bed, instead of being raised with pecks, or iron bars, as is common when it lies near the surface. The rock on which it lies, soon changes to a firm, compact limestone, and looses its silicious character. When found in detached masses near the tops and sides of hills, it is ochery, or orange colored, with numerous cavities lined with mamillary processes, of chrystalized carbonate of iron, some of which are very beautiful, and afford nice specimens for the cabinet. The ore is from two to five and six feet in thickness; the upper surface of the bed being undulated, but the under surface resting on the lime rock is smooth and uniform. It also improves in quality as it increases in thickness.—This bed is easily traced to the distance of ten or twelve miles in a south easterly direction, and finally disappears beneath the bed of the river, at "coal grove," above Hanging Rock. It is extensively worked at all the upper furnaces in Lawrence county, and also in Kentucky. Its extent, in the line of its bearing, is yet unknown; but is probably continuous with number three, as a similar ore is believed to be found and worked below Zoar, in Tuscarawas county. It may probablybe reached by shafts many miles further east, and afford exhaustless supplies to the future manufacturers of the west. When smelted, it yields about fifty per cent. of very fine iron. The analysis is given in the appendix at No.

Reposing on No. 5, lies a deposit of brown argillaceous shale, nine feet in thickness, resting on which is a bed of fine white clay, three feet in thickness, of a quality suitable for pottery, or as a material for fire bricks. It is already extensively used in the manufacture of stone ware; and has also been found to yield with dilute sulphuric acid, a fine sulphate of alumina, or allum. The white clay forms the floor of a bed of bituminous coal, four or five feet in thickness. It is said to burn freely, and is thought will be exceedingly valuable in the smelting of ores, when the "*hot blast*" shall be brought into use, as it already is at some of the furnaces, and must soon be at them all. If its success is equal to the statements made in the European journals, as noted in the appendix [A[a new era will commence in the iron manufacture; and not only a larger amount be obtained with a less quantity of fuel, but also a better article of iron. The immediate roof of the coal is composed of a chocolate colored shale, reposing on which rests a bed of sand stone, sixty feet in thickness. The lower portions of this rock contain numerous imbedded fragments of coal. Resting on the sand rock is found a thin bed of yellowish, or cream colored limestone, probably tinged by ore bed No. six, which here crowns the tops of the hills. It is a calcareous ore and needs no addition of lime in fluxing. The structure of this ore is very different from that of the other beds; resembling a mass of aglutinated pebbles, or a closely aggregated pudding stone. It affords about fifteen or twenty per cent. of iron, but is as yet little used by the furnaces. The bed is three feet in thickness, and

would probably afford more than four thousand tons of ore to the acre. It is apparently either the same, or an equivalent bed to that described as No. one, at Dillon's furnace, in Muskingum county. This deposit is the last of the series of ores yet noticed on the Ohio side of the river; but on the Big Sandy river, a few miles from the mouth, are extensive beds of limestone iron ore, from eight to ten feet in thickness. This ore has been used at the "Oakland furnace," and yields about thirty-three per cent. of iron. It will, without doubt, be found in Ohio, in a similar parallel whenever a regular survey of the State shall be made.

With these immense, and apparently exhaustless supplies of iron at her command, what shall prevent Ohio from becoming one of the first manufacturing states in the Union? Cincinnati, emphatically called "the queen of the West," has within her reach all the means of wealth and greatness. The Ohio river, washing with its gentle current the ores and the coal as they lie slumbering along her shores, is ready to waft on her bosom, at all seasons of the year, and at the cheapest rates, a regular supply of materials to the door of the manufacturer. Her proximity to the iron will give her a decided advantage over Pittsburgh in the cost of the article; while the increased number of coal beds opening, and to be opened, will soon furnish coal at as cheap a rate as it is now furnished at the latter place.

LIST OF FURNACES IN SCIOTO AND LAWRENCE COUNTIES.

In order to aid in forming a correct estimate of the value and importance of the iron business to Ohio, in its present infant state, the Committee have subjoined a list of the furnaces in operation the past season, the amount of iron smelted, with its present value per year.

NAMES OF FURNACES.

Franklin, Junior, Scioto, Bloom and Clinton, in Scioto county.

Union, Pine Grove, Ætna, Vesuvius, Hecla, Lawrence, Mt. Vernon, and Buck Horn, in Lawrence county.

In addition to these, are two forges; the Lafayette and Hanging Rock.

The furnaces make an average amount of one thousand tons of pig iron per year; some of them making more than this quantity and others less. During the past season, pig iron has been worth forty dollars per ton at the landing, where the metal is delivered to purchasers. Producing an amount of iron worth five hundred and twenty thousand dollars per year—one half of this quantity is made into castings and stoves, directly as the metal flows from the furnace, worth sixty dollars per ton, which will add one hundred and thirty thousand dollars more to the gross amount; making the sum of 650,000 dollars as the product of these 13 furnaces. The number of furnaces is steadily on the increase, several new ones going into operation the present year. In addition to which, the bar iron manufactured at the forges will swell the present amount to a considerable larger sum. Each furnace employs, on an average, about one hundred men, and fifty yoke of oxen—all which are fed from produce grown in these counties and those lying higher up the country on the Ohio and Muskingum rivers; affording an extensive homemarket for large quantities of corn, oats, flour, and bacon, and already nearly as important as that of Cincinnati, to many of the river counties. The furnaces on the Kentucky side of the Ohio river, in the iron ore region, are quite as numerous as those in this State, and assist in giving permanency and value to this new market. When the number of furnaces is quadrupled, as they in a short time must be, from the regularly increased demand for iron in rail roads, steam engines, &c., the value of the iron manufacture will be swelled to several

millions, and the market for the productions of the soil be proportionally increased. So true it is, that agriculture and manufactures are twin sisters, and go hand in hand, affording mutual benefit and assistance to each other.

IRON ORE BEDS IN MUSKINGUM COUNTY.

The probability of finding the same beds stretching in continuous deposits, nearly across the State, with only partial interpositions, is so great that the ore beds in Muskingum county, were also visited. How far this opinion is strengthened by the examination, will be shown in the section of strata given below. Every new fact leading to this conclusion, would add to the inducements for entering into a thorough geological survey of the State. Although at the first view, it may appear visionary to suppose that such vast and extensive deposits of ore can be found in any region of the earth, yet when we reflect that the operations of nature have been carried on in the valley of the Mississippi, of which Ohio is a part, with a grandeur and magnificence unknown to most parts of the earth, it will not be so difficult to believe. Having personally visited both the north and the south sides of the valley of the Ohio, and examined the different strata, we have come to the conclusion that the coal beds and iron ores, are systematically placed between vast and extensive deposits of sand rocks, shale, or clay slate and lime stone—which several strata were originally formed in a vast basin, covered with water, the gradual filling up of which has changed it to dry land. In the most depending part of this basin, the Ohio river now flows. Subsequent to this period, or during its progress, the Allegheny ranges were thrown up from below, and the table lands on the heads of the streams between Lake Erie and the Ohio, were also raised. Many of these deposits are doubtless extended entirely across the valley, as we are led to suppose from the products of the borings of salt wells, and from finding similar rocks on the two opposite sides of the basin, especially red sand stone, and mill stone grit, as at the falls of the Cuyahoga, and in the Gaula and Laurel mountains, as well as at other points around the margin of the coal basin. Both these rocks are known to underlie those deposits. From this raising of the borders of the valley, those strata which lie at the depth of several hundred feet in the centre of the basin, appear on the surface at the margin—while those which are at a less depth come to the surface in succession as we travel towards the centre of the basin, as is partially shown in the section of strata in Scioto and Lawrence counties. The same order as is there exhibited, varying, however, in thickness, quality, &c., it is more than probable, is continued all round the western and northern portions of the coal region. The rocks containing fossil salt, lay deeper than the bituminous coal, as the strongest and best water is found on the shores of the large streams, some distance from their heads, and after penetrating the upper coal deposits—although it is not unphilosophical to suppose that beds of anthracite may be found below the salt rocks, from the fact of sulphurated hydrogen and petroleum being discharged from the bottoms of the deepest wells, both of which are supposed to be the products of coal.

With these remarks, we now proceed to notice the arrangement of the strata, at a point about one mile west of Dillon's furnace. The section below will assist in rendering it more plain.

BITUMINOUS COAL.

Proceeding up the Ohio, after leaving Lawrence County, no additional deposites of iron ore have as yet been noticed, sufficient to attract the attention of the manufacturer; but we find that which is equally valuable, fine beds of coal, without which, in a few years after the forests are destroyed, ores cannot be smelted. A few miles below Gallipolis, fine beds of coal are found on both sides of the river, known as "Semple's coal mines." It is extensively worked, and affords an abundance of fine coal. The most important deposit, however, is found stretching along the borders of the Ohio, from the mouth of Leading creek to two miles above Carr's run, a distance of eight or ten miles by the course of the river. It is generally known by the name of the "Pomeroy coal beds." A northerly bend in the Ohio, has thrown these rich deposites immediately on to the brink of the river. Although the early settlers of the country, looked with an evil eye on the rocky narrows of the Ohio, and considered lands thus situated as nearly worthless, yet we are led to admire the kind hand of Providence, which, by causing the river to flow in sweeping curves, has thus brought the most valuable beds of iron, coal, and sand rock, immediately on to the shores of a navigable stream; and instead of the lengthy rail roads across wide bottoms, which would be necessary were both shores alluvious, the workmen can now transfer the products of the mine, almost immediately from its mouth, into the boat which floats it to market. The mural precipices of sand rocks which line the right bank of the Ohio, not only afford a safe roof to the mines, but also offer an exhaustless store of free stone for architectural purposes, in the erection of the future cities and manufactories, that will spring up along the shores of the river. The coal at these beds is from four to six feet in thickness, and of the best quality for manufacturing purposes, affording a large per cent. of carbon. By a recent analysis it is found to be composed as follows—charcoal or carbon 60 parts—bituminous matter and earth 40 parts—specific gravity 1.22.

The enterprizing individuals who at present own the larger moiety of these beds, have overcome difficulties in transporting a regular supply of fuel to the markets below, which in other parts of the United States, have required the united energies of incorporated companies to conquer. A large steam-boat built expressly for the purpose, tows from four to six loaded barges, carrying each from five to seven thousand bushels of coal to Cincinnati and back again empty; performing the trip in five or six days—at this spot, which three years since looked like a neglected wilderness a smart village has sprung up, filled with an industrious race of men. Steam saw-mills, shops, and a large boat-yard are in active operation. The colliers are chiefly experienced miners from Wales, with their families. A church, and a school-house are about being built from the fine sandstone, for the cultivation of the rising intellect, and encouraging the growth of morality and religion amongst the miners. A spot which a few ago was considered by the neighboring inhabitants as almost worthless, and parcels of the coal lands often actually sold for less than a dollar and a half per acre, is now worth an incalculable sum. How often a community is indebted for its wealth and comfort to the foresight and intellectual greatness of a single individual The lands of the whole surrounding country for many miles, contiguous to the coal beds, have been trebled in value, and an extensive market opened for their surplus produce. Coal will now be supplied with regularity, and in quantity to the inhabitants of Cincinnati, instead of by uncertain boat loads, and at irregular intervals

as heretofore. It will also be of a better quality, as the coal improves, when the beds are followed far under the rocks. With these large supplies of coal, and iron in exhaustless beds, lying directly on a navigable stream, but a short distance above, for steam shortens space, as well as time, "the Queen of the West," is destined to become, and that in a few brief years, the emporium of manufactures; and nothing but a lack of enterprize and inattention to the immense resources heaped up in her vicinity can prevent her taking the lead in the fabrication of all articles manufactured from iron. Enough has been said to awaken the attention of the community to the subject; and a liberal policy in our legislators, authorizing a scientific geological survey of the State, can hardly fail in developing resources before unknown and unthought of, leading to an eminence of wealth and greatness, equal, if not superior to that of any other state in the Union.

The Pomeroy beds, alone, will probably in another year furnish a million of bushels of coal to the markets on the shores of the Ohio; and other beds seated along its borders can supply additional amounts equal to the demands of the manufacturer and for domestic purposes.

As we proceed up stream, no other considerable beds are found near the river for the distance of one hundred and forty miles, or until we reach Pipe creek, sixteen miles below Wheeling. Here the coal which has traversed the higher strata along the adjacent hills, bordering the river, for many miles above Wellsburgh, gradually dips below the bed of the river, and is seen no more in thick beds until it appears at Carr's run.

In Ohio, opposite to Wheeling, and in the counties of Belmont and Jefferson, coal is found in three distinct deposites and in exhaustless quantities; but those beds near a navigable stream, must ever be deemed much the most valuable and important. It is also discovered as far north as Portage and the S. E. corner of Medina county, in considerable quantities—but the main deposites are south and east of these lines and in fact all round the inner margin of the sand stone basin, especially in the counties of Athens, Perry, Muskingum, Coshocton, Tuscarawas, Carroll, and Columbiana. Canals and rail-roads will in a few years make these deposits available to those portions of Ohio, which lie without the coal region.

FINE GRAINED SAND ROCKS.

In describing the iron ore deposits of Scioto county, it will be recollected that the bed No. one is noted as resting on a fine grained sand stone. This rock forms the upper surface of a very extensive deposit, underlying the iron ores and the coarser sand rocks, and coal, mentioned in the commencement of the Report. As this rock descends deeper into the earth it becomes more argillaceous; and at the depth of one hundred feet changes, to or rather rests on, a bed of clay state, of a light dove color, easily decomposing, when exposed to the weather. Underlying this rock, at the depth of 340 feet, there are many reasons for believing, there is a bed of coal twelve feet in thickness. It has been pierced at two different points in boring for salt water. So certain and plain were the evidences of its actual existence, that a shaft, eight or nine feet in diameter was sunk to the depth of one hundred and fifty feet in search of the coal, in the year 1833. But untoward events happening to the company, the further progress was laid aside, with the intention of resuming the work at a more favorable period. In a conversation, with one of the original occupants of the salt well, bored at this spot, the evidences of a coal bed of this thickness were very satisfactory. Salt water was found below the

coal of unusual strength, but would not rise to the surface in the usual manner, common at other wells and was therefore abandoned. Should this coal be ultimately obtained, it will be of incalculable benefit to the iron manufactures of this vicinity. The shaft was sank near the mouth of Man's creek four miles above Portsmouth, on the Ohio. On the diagram, the supposed position of this bed is laid down.

On the west side of the Scioto, near its mouth, the upper beds of this fine sand rock have been extensively opened, and the rock sawn into slabs and other forms useful in architecture, by a mill moved by water power, supplied from the canal. The stone is just rising into notice, and the demand for columns, capitals, plinths, &c. is already far beyond the means of the proprietor to supply. Some of the whiter varieties, when wrought by the chisel and ornamented, furnish an article which vies with white marble in beauty. It is sufficiently firm to allow of the most delicate execution, in raised ornamental figures; and is said to bear the vicissitudes of our climate withot decomposition. Its termination westerly is not yet ascertained; but it extends up the Scioto for many miles, and the beds at Waverly are already known, at Columbus, and in some of our principal inland towns, as affording a most beautiful and durable material for architectural purposes. In a country destitute of marble this fine grained sand rock will furnish an equivalent, of immense value and importance. It will be the duty of the geologist to point out the various spots where this rock may be found, at localities far beneath the surface, and which may be reached by shafts, in the manner pursued at Paris and many other places in Europe.

CALCARIOUS ROCKS.

The western and central divisions of Ohio, beyond the coal measures, are based on horizontal beds of lime-stone, supporting rich prairies. The deeper strata from the absence of hills, are as yet but little known; but may possibly contain valuable beds of anthracite. This supposition is strengthened, from observations made by the chairman of the committee in a visit last summer to the Delaware Sulphur Springs. In breaking fragments of the lime rock about Delaware, he noticed a strong bituminous effluvia; and in a conversation with an old quarry-man, he learnt that small cells are found in the rocks filled with petroleam, or "spring oil." The gas discharged from the spring is sulphurated Hydrogen, both which products are known to be furnished by coal. From these indications it will be worthy the attention of the Geologist, should a survey be directed by the state, to cause borings to be made through the lime-stone rocks, to the depth of several hundred feet, similar to those made in search of salt water, at various points in the interior, where no indications of coal, are noticed on the surface. It may also bring to light other valuable minerals. The time is not distant when all that portion of the state occupied by prairies, will need more fuel than can be furnished by the forests, and could coal be found at a moderate depth, the value to the inhabitants would be incalculable.

SALT WATER AND SALT.

This article, so indispensable in the economy of civilized man, and so abundantly procured at various points through the hilly, sandstone region, has not yet been found in any considerable quantity, beyond the limits of the coal measures. Within these boundaries it has been discovered and manufactured, at Leading creek, Hockhocking, Muskingum, Wills creek, Duck creek, and Yellow creek. It is highly probable that a scientific survey would discover indications of this mineral at points now little

thought of in the N. Western portions of the State. This supposition is strengthened from the fact of Sulphate of Lime, or "Plaister of Paris," a well known concomitant of fossil salt, being found at Sandusky bay; and also from the curious circumstance of the Moravian Missionaries, having made salt from springs, found near the outlet of Lake St. Clair as early as the year 1783, as noted in Loskiel's history of the Moravian Missions. The product of this article in Ohio, has become so great, that it may be accounted one of its staple commodities. The nett annual amount of all the works cannot be less than half a million of dollars.

"BEST METHOD OF CONDUCTING THE SURVEY."

In the opinion of your committee, the better mode of conducting the survey, will be by constituting a Geological Board, of three members; who should direct the manner of proceeding; employ suitable geologists &c. with power to draw on the Treasurer, or the deposites annuully appropriated for this purpose; or otherwise, the present Board of Public Works, might perform this duty, as might be deemed most expedient.

"COST OF THE SURVEY."

From a correspondence held by the chairman with several distinguished and practical men in geology, your committee are led to believe that the sum of $12,000 dollars, for four years would cover the cost of a regular scientific survey. It would require the services of one head, or principal geologist, and five assistant geologists. One draughtsman, one naturalist. Their salaries, travelling expenses, and other incidental charges would amount to nearly this sum. The survey to be complete, and most useful to the community, ought not only to embrace the simple geology, but also the topography, botany, so far as to include a list of the plants found in the State, forest trees, river and land shells, fishes, birds, quadrupeds, and reptiles—and last, not least, a regular survey and description of all the remnants of ancient works, yet spared by the hand of the destroyer within the state. These relics of a departed and more than half civilized race, it is our duty to preserve for those who come after us, in the only way now left for many of them, by accurate drawings and descriptions of all such as can be distinctly traced. It should also be enjoined on the surveyors to collect all the remains of art belonging to this race, whom we have many reasons for believing were the ancestors of the Mexicans, such as pottery, sculpture in stone, offensive weapons, ornaments &c. to be placed in a cabinet in the State Library Hall—with specimens of all the rocks, minerals, fossils &c. in a regular geological series, not only for the State, but also a suit for each of the collleges. These Collections would be of immense value to the student of geology, mineralogy, and the practical miner; as well as to the future historians of the State.

CONCLUSION.

Although many things yet remain unnoticed, such as the marls of Wayne and Stark counties; the silicious or Burrh millstone deposits, stretching diagonally across the State, with several other important subjects, yet your committee trust and believe that they have pointed out sufficient motives to render a survey of the state an object of deep importance to he welfare of the citizens of Ohio. The increased value of real estate, or the additional revenues derived from the canals and rail roads, from new articles of transport brought to light by the survey, would in a single year, probably more than repay the cost of accomplishing it. Several of the eastern States, whose territories contain far less mineral treas-

ures than Ohio, have already either accomplished, or are now entering upon, geological surveys. That great and public spirited State, New York, ever amongst the foremost in the march of improvement, has taken up the subject with a zeal and an outlay, commensurate with so noble an object. Virginia, our next neighbor, is on the alert; searching with all the aids of science not only amidst her mountain ranges of auriferous rocks, and golden sands, but also her ferruginous, salt, and coal deposits, the counterparts of our own. And shall Ohio, already the third state in the Union for physical power, remain behind her sisters in the scientific improvements of the age?

S. P. HILDRETH, *Chairman.*

Postscript.—The other members of the committee, Mr. Riddle and Mr. Lapham, being both absent from the state, and Dr. Lock occupied with his duties as Professor in the Medical College of Ohio, has necessarily prevented the signature of their names to the report.

Mr. Riddle, in the course of the last summer, made a tour of exploration through the north western and central portions of the state, and collected many valuable geological facts, which have not yet come into the hands of the chairman. Dr. Locke, who kindly undertook the analysis of the iron ores, referred to in the report, has been prevented, by unexpected events, from accomplishing the task in due time; they will however, be furnished in a few weeks, and will be very valuable to persons engaged in the manufacture of iron, as well as to general science.

ANALYSIS OF THE LIME-STONE OF CINCINNATI AND DAYTON.

BY JOHN LOCKE, M. D.

One hundred grains of the grey lime-stone from the hills of Cincinnati, yielded the following ingredients:

	Grains.
1. Carbonate of Lime,	90,93
2. Peroxide of Iron,	3,15
3. Matter insoluble in Muriatic acid,	1,80
4. Carbonate of Magnesia,	1,11
5. Silex from solution,	0,77
6. Water, &c. expelled by red heat,	1,13
Loss,	1,11
	100,00

One hundred grains of the cream colored lime-stone from Dayton, yielded the following ingredients:

	Grains.
1. Carbonate of Lime,	92,40
2. Peroxide of Iron,	0,53
3. Matter insoluble in Muriatic acid,	1,70
4. Carbonite of Magnesia,	1,10
5. Selix from solution,	0,90
6. Small crystals of iron Pyrites,	0,10
7. Water, &c. expelled by red heat,	1,08
Loss,	2,19
	100,00

The matter, in the Cincinnati Limestone, insoluble in Muriatic acid is of a dark lead color. It is evidently silex and alumine, not combined

with the carboniate of Lime, but mechanical interposed between the natural joints of the crystals, and there giving the color to the whole stone. The similar substance of the Dayton Limestone is of a cream color; and that from a specimen of saccharine white marble from Italy, was in very small quantity and white. The dark color of the Cincinnati Limestone when slacked, and which renders it unfit for white washing, is caused by the superior quantity of iron which it contains. This analysis will serve to settle one point of some consequence in Cincinnati. Our masons have formerly pleaded that the Cincinnati Lime is of so 'hot a nature' that they were compelled to use loam in their mortar. The introduction of this loam in large quantity when they furnished the materials, was obviously to their advantage; and in some cases it almost excluded the more expensive materials, lime and sand. When masons do not pay for materials, but are employdd to perform the labor merely, the temptation to introduce the loam (a species of clay,) is not so obvious to the employer. The temptation is this: when the mortar is a large proportion of it mud, it does not harden ('set') so soon, and the mason can throw on a 'run' of perhaps ten bricks which he can lay in succession without being interrupted by laying mortar; while with mortar composed of pure lime and sand not more than two or three bricks could be laid at once. It is on account of the use of this imperfect mortar that the tops of our chimneys and copings of walls are so soon dilapidated. Now as the pure chymical principle of Lime is every where the same, and our Lime contains at least 93 parts in a hundred of it, this 'hot quality' is imaginary. Many of our best masons are now building with pure lime and sand to the exclusion of loam;—an improvement which I hope will be encouraged. The analysis shows the presence of Magnesia, but in too small a proportion to injure it in the least for agricultural or other uses. The Magnesian carbonate of Lime contains 45 per cent. of Carbonate of Magnesia, while ours has only about 1 per cent. The specific gravity of both the Dayton and Cincinnati specimens was 2.7. Very few specimens of Lime stone are known purer than those subjected to the above analysis.

APPENDIX A.

On the application of the Hot Blast, in the Manufacture of Cast Iron, by **THOMAS CLARK, M. D.** ***(Trans. of the Royal Society of Edinburgh.)— Copied from the Amer. Jour. Sci. for Oct.*** **1836.**

"The substitution of hot for cold air, in the blast furnaces of the iron manufactory, is an improvement which suggested itself to the ingenious Mr. Neilson, of Glasgow, at a most seasonable period, when the great demand for iron in the construction of rail-ways, is daily, nay, hourly, increasing.

"The original process consisted in introducing a charge of coke, limestone, and burned iron stone, into the top of the furnace; and this mixture was excited to combustion by air forcibly driven in, at about forty feet from the top, through pipes from a blowing apparatus. The iron was thus separated from carbonic acid, alumina and silica—and was allowed to run off at the bottom.

"Mr. Neilson improved this process, by substituting for air at the temperature of the atmosphere, air heated up to 300 degrees, and upwards.

This is effected by passing the air through the cast iron pipes, by which the former passed, kept at a red heat.

During the first six months of the year 1829, when the cast iron in the Clyde iron works was made by means of the cold blast, a single ton of cast iron required for fuel to reduce it, 8 tons 1¼ cwt. of coal converted into coke. The saving amounts to 2 tons 18 cwt. on the making of one ton of cast iron—but from that saving comes to be deducted the coal used in heating the air, which was nearly eight hundred. The nett saving was thus 2¼ tons of coal on a single ton of cast iron. But during the year 1830, the air was heated no higher than 300 degrees Farenheit. The great success, however, of these trials, encouraged Mr. Dunlop, and other iron masters, to try the effect of a still higher temperature. The saving of coal was greatly increased, insomuch that about the beginning of 1831, Mr. Dixon, proprietor of the Calder iron works, substituted raw coal, for the coke before in use. Proceeding on the ascertained advantages of the hot blast, the attempt was entirely successful; and since that period, the use of raw coal has extended so far as to be adopted in the majority of the Scotch iron works. The temperature of the air under blast, had now been raised so as to melt lead, and sometimes zinc, and therefore was above 600 degrees Farenheit, instead of 300 degrees, as in the year 1830.

"During the first six months of the year 1833, when all these changes had been fully brought into operation, one ton of cast iron was made by means of 2 tons and 5¼ cwt. of coal, which had not previously been converted into coke—add to this 8 cwt. for heating the air, and we have 2 tons 13¼ cwt. of coal required to make one ton of iron: whereas, in 1829, with the cold blast, 8 tons 1¼ cwt. of coal had to be used. This being three times as much, we have from the change of the cold blast to the hot, combined with the use of coal instead of coke, *three times as much iron made from any given weight of splent coal.*

"The furnaces at Clyde iron works, which were at first three, have increased to four; and the blast machinery being still the same, the following were the successive weekly products of iron during the periods already named and the successive weekly consumption of fuel put into the furnace apart from what was used in heating the blast:—

	Tons.	*Tons.*	*Tons.*
In 1829, from 3 furnaces	111 iron	from 403 coke,	from 888 coal.
In 1830, from 3 furnaces	162 iron	from 376 coke,	from 836 coal.
In 1833, from 4 furnaces	245 iron		from 554 coal.

"Comparing the product of 1829 with that of 1833, it will be observed, that the blast in consequence of being heated, has reduced more than double the quantity of iron. The fuel consumed in these two periods we cannot compare, since in the former coke was burned, and in the latter coal. But in comparing the consumption of coke in the years 1829 and 1830, we find that although the product of iron in the latter period was increased, yet the consumption of coke was rather diminished. Hence the increased efficacy of the blast appears to be expected, from the diminished fuel that had become necessary to smelt a given quantity of iron.

Materials constituting a Charge at the Clyde Works.

In 1829:—

Coke, 5 cwt. 0 qr. 0 lbs.
Roasted iron stone, 3 cwt. 1 qr. 14 lbs.
Lime stone, 0 cwt. 3 qrs. 16 lbs.

In 1833: with the hot blast:—

Coal, 5 cwt. 0 qrs. 0 lbs.
Roasted iron ore, 5 cwt. 0 qrs. 0 lbs.
Lime stone, 1 cwt. 0 qrs. 0 lbs.

1836

MISCELLANEOUS OBSERVATIONS

ON THE

GEOLOGY OF OHIO.

BY I. A. LAPHAM.

It has been doubted, whether the limestone found in the western part of the State of Ohio, passes under the coal strata, occupying the eastern part, or is underlayed by them; and it has been suggested, that it graduates into argillaceous shale and sandstone. I will mention the facts which have satisfied me that the limestone is a distinct formation of a greater age, and underlaying the coal formation.

1. The limestone found on the Scioto river, two miles above Columbus, is similar, in many respects, and contains similar organic remains to the limestóne at Louisville, Kentucky, *which passes under* bituminous shale.

2. On Mackachack creek, in Logan county, the same kind of shale is seen resting on the limestone.

3. The limestone at Columbus is the kind called "Cornutiferous" by Professor Eaton, which, at Black Rock, N. Y. passes under the coal formation, (Pyritiferous shale of Prof. Eaton).

4. Above Portsmouth, the strata are found to have a dip towards the southeast of about 16 feet to the mile.* They belong to the coal formation. A few miles below Portsmouth, in a direction opposite to the dip of the strata, we find limestone, which, therefore, must lie lower in the series.

5. The limestone contains fossils of the trilobite family, and is, therefore, referable to the *Transition* class of rocks; for these fossils are peculiar to Transition rocks.† But the coral strata are *secondary*, —a class of rocks found above the *Transition*. According to Bakewell, a distinguished English geologist, "the great coal formation appears to be confined to the *lower secondary* strata, generally *resting on transition limestone*."‡

6. At Carpenter's mill, four and a half miles above Worthington, the bed of the Olentangy river is composed of limestone, similar to that found on the Scioto, near Columbus. It has a very perceptible dip towards the south east, and in that direction about half a mile, is a high, steep, bluff, composed of bituminous shale. The same fact was observed at Delaware.

* Dr. Hildreth—Silliman's Journal, Vol. 29, p. 136.

† Bakewell's Geology, (1st Amer. Ed.) p. 106.

‡ Ibid. p. 127.

The following observations were made by my brother, DARIUS LAPHAM:

"About half way between Columbus and Worthington, we ascend a slight aclivity, above which we observe the bituminous shale. Worthington is based on this formation. The valley of the Olentangy below Delaware is quite narrow, seldom exceeding half a mile, and sometimes not a quarter of a mile in width. The bed of the stream from a few miles above Worthington, to a couple of miles above Delaware, is composed of limestone, which rises sometimes twelve or fifteen feet above the water—at other times no higher than low water mark. Upon this lies the bituminous shale, crowned with alluvion and diluvion. I *saw the junction* of the two rocks. They alternate with each other several times. Layers of dark colored hornstone alternate with the slate towards the bottom of the stratum, generally about one and a half inches thick. Three miles above Cardington commences a layer of sandstone resting on the slate which is seen at that place and some distance above. We saw no sandstone in place, but numerous blocks occur, and it is used in building—it resembles that quarried on Paint creek, near Chillicothe. Its laminæ are from two inches to a foot thick, and it is an excellent grindstone grit. Above this we entered upon the Sandusky plains or prairies."

The valley of the Olentangy appears to run near the junction between the limestone and slate, while that of the Scioto is cut through the solid limestone.

[Here was inserted a figure representing the Olentangy running between limestone and slate, and the Scioto running through solid limestone, but was omitted for the want of an engraving.]

Occasionally, however, the Olentangy runs over slate rock, and at other places over limestone.

That this slate belongs to the coal formation, is evident from the fact that thin seams of coal, of a few inches in extent have been found in it. The curious globular masses described in Silliman's Journal,* and the Western Medical and Physical Journal,† are found in this rock.

At Delaware, there is a sulphur spring, which is much frequented by the citizens, on account of its medicinal qualities; and preparations are making to accommodate visiters from a distance. A commodious building is already erected, and the grounds are laid out with much taste. Free access to the spring is secured to the public.

The peculiar odor of sulphuretted hydrogen is perceived at some distance from the spring, and this gas rises at intervals of a few seconds through the water. When closely examined, the water is found to contain numerous, minute, white particles, which are deposited on the bed of the stream below.

The result of the analysis of this water, made by Prof. H. Mitchell

* Vol 25, p. 249. † Vol. 27, p. 356.

of Kenyon college, as published by the proprietor of the spring, is as follows:

One wine pint contained

Sulphuretted hydrogen gas,	12 cubic inches.
Carbonic acid gas,	3 cubic inches.*

One hundred grains of the deposite, obtained by evaporating several gallons of water, contained

Muriate of soda,	48	grains
Muriate of lime,	20	"
Sulphate of Magnesia,	16	"
Sulphate of lime,	8	"
Carbonate of lime,	5	"
Loss,	3	"
Total,	100	"

There are also in the vicinity of Delaware, several chalybeate springs.

A sulphur spring has also been found on the farm of Mr. Miner, two miles below Franklinton, which appears to be quite similar to that at Delaware.

It is highly important to have the medicinal value of these springs ascertained and published.

The valley of the Scioto, from Columbus to the mouth of Mill creek, a distance of twenty-three miles, and perhaps further, appears, as before observed, to be cut through limestone—the banks are in many places perpendicular, or even overhanging. This limestone, which is a part of the great calcareous formation of the Western country, is filled with remains of marine animals. Near the river are found many "sink holes," or places where the rock has been dissolved and carried away, leaving large funnel-shaped cavities in the ground. In many places these sinks are connected with the river by subterranean passages; so that the road in these places passes over natural bridges or culverts.

A cavern about five miles above Columbus, on the farm of Mr. Alexander McCoy, called the "rattle-snake den," on account of the number of rattle-snakes that formerly inhabited it, is worthy of a particular examination. It is supposed to be connected with a "sink hole," a quarter of a mile from its entrance.

A boring was made in this rock three miles below Mill creek, on the Scioto, in which it is said that salt water was obtained, but on account of the difficulty of separating it from the fresh, it has never been worked.

At a point two miles below Jefferson, on Darby creek, limestone oc-

* There is probably some error in this. The water of the Harrowgate spring in England, which this is said to resemble very closely, contains only about 2 1-2 cubic inches of gaseous matter in a wine pint.

FIRST ANNUAL REPORT

ON THE

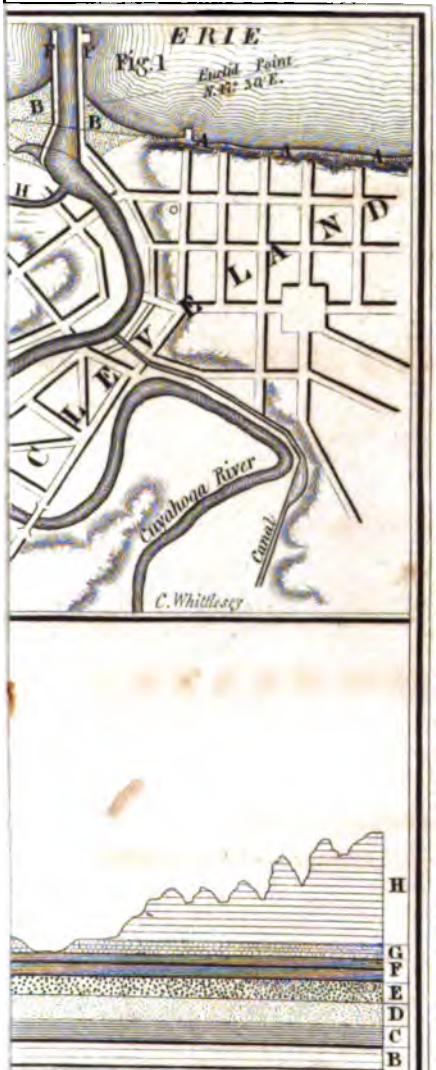
GEOLOGICAL SURVEY

OF THE

STATE OF OHIO.

BY W. W. MATHER,
PRINCIPAL GEOLOGIST, AND THE SEVERAL ASSISTANTS.

COLUMBUS:
SAMUEL MEDARY, PRINTER TO THE STATE,
1838.



...ile, which is greater than the mean dip.

G. *Calcareosilicious rock.*

H. *Upper coal series.*

W. W. Mather

Doolittle & Munson Cin.

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EXECUTIVE OFFICE, OHIO,
Columbus, January 17, 1838.

To the General Assembly of the State of Ohio:

I have received, and herewith transmit to you, the reports of W. W. MATHER, and his ASSISTANTS, c ing the Geological Corps of this State, numbered seven, inclusive.

JOSEPH VANCE.

No. 1.

FIRST ANNUAL REPORT

ON THE

GEOLOGICAL SURVEY OF OHIO.

BY W. W. MATHER, Principal Geologist.

To his Excellency, JOSEPH VANCE:

SIR: In obedience to your directions, and under the authority of an act of the Legislature, a Geological Survey of the State has been commenced. The early part of the season was devoted to making a geological reconnoisance of the eastern section of the State, with a view to study the great outlines of its geology, and to acquire a knowledge of the general resources of the country in useful minerals, so as to direct the detailed examinations in such a manner, as to be productive of the greatest utility to the great body of the people. The mineral wealth of Ohio is greater than my most sanguine anticipations had led me to expect. Most countries depend, for their mineral wealth, on mountainous or barren regions; but Ohio, in common with some other parts of the United States, is blessed, not only with a fruitful soil, but also with inexhaustible subterranean riches.

In your late annual Message, you have remarked upon the coal and salt deposits, and urged the necessity of new lines of intercommunication to facilitate the transport of our mineral products.

The working of the coal mines of Ohio, which may be considered inexhaustible, must become one of the most productive branches of industry in the State.*

From the reconnoisance of the past season, it is estimated that about 12,000 square miles of the State, are undoubtedly underlaid by coal, and 5,000, by workable beds of this valuable mineral. In many places, several successive beds of the coal are superposed one over the other, with sand-stone, iron ore, shale and lime-stone intervening. The coal beds are favorably situated for working, as they are found in the hills and ravines where they can be drained with little expense, and without deep shafts and expensive machinery, like those of Europe, or some parts of our own country. It is impossible, with the data as yet ascertained, to estimate the amount of workable beds; but probably a mean thickness of 6 feet of coal capable of exploration over 5,000 square miles, is a moderate estimate of our resources in this combustible. Our citizens are not yet aware of the prospective

*The coal formation constitutes the principal mass of the S. E. section of the State, and the economical geology of a portion of this, lying between the waters of the Scioto and Great Hockhocking, only, will be discussed in detail. Prof. Briggs was directed to prosecute this work, and the details will be found in his report.

value of coal lands; and it is, perhaps, only by setting their practical utility before them, that they will appreciate the importance of this mineral on their estates.

It requires a man of the greatest muscular power, to raise 3,750 pounds one foot per minute, through a time of ten hours per day, which is equal to 2,250,000 pounds, or more than 1,000 tons; but one bushel of coal applied to steam machinery, produces a power equal to that of lifting 60,000,000 to 90,000,000 pounds one foot high.* Taking the lower power of 60,000,000 of pounds, which is equal to more than 26,785 tons, the power produced by the combustion of one bushel of coal in the present improved steam machinery, is equal to the greatest muscular force of 26 men for a day of 10 hours' labor. Coal is worth, in Ohio, from 4 to 18 cents per bushel; and a man's daily labor, from 50 cents to $1,50.

A furnace, consuming 700 bushels of charcoal per day, for 200 days in the year, will require from 2,000 to 5,000 acres of woodland to keep it constantly supplied. Coal land, with only 1 yard in depth of coal, would supply the same furnace at the rate of one acre per year, while the coal land would still remain in a state fit for cultivation.

When we reflect upon the quantity of wild land necessary to keep one furnace in operation, where charcoal is employed, we can easily conceive how great an advantage it will be, to be able to use a combustible which is stored below the surface of the earth in inexhaustible quantities, while the soil above, may be covered with abundant harvests, and with thriving villages, towns and manufactories.

The annual consumption of coal in England is from 14,000,000 to 15,000,000 of tons. If wood were used in lieu of this, it would be necessary to keep an area of land in a wild state, nearly 200 miles square. This area is greater than that of England and Wales, in which this consumption takes place. The coal deposits of England, therefore, are indispensable to enable her to support so dense a population, and maintain her commercial prosperity and manufacturing interests. Every square mile, containing two yards in thickness of workable coal, will yield about 6,000,000 tons, which is an abundant annual supply of fuel for all the people of this State, both for domestic and manufacturing purposes; and, if we allow double this amount for prospective consumption, in consequence of increased population and manufactures, we have coal within a moderate depth, sufficient for consumption during 2,500 years. If we consider the value of coal as a means of *motive power* in propelling machinery, each acre, of the 5,000 square miles of coal, contains stored and ready for use, a power equal to that of 192 men for 100 years, working 10 hours per day. Allowing a profit of only 25 cents on each cubic yard of coal, an acre would yield a profit of more than $2,000 where a depth of 6 feet is worked.

These facts will, it is hoped, lead our citizens to appreciate the vast

*Vide the duty of the Cornish steam engines in Taylor's Records of Mining.

mineral resources in this valuable combustible, with which our territory, through Infinite Wisdom, is so bounteously supplied.

Iron Ore.

The iron ores of Ohio are abundant, and are beginning to be extensively worked. The extent of country underlain by accessible beds of iron ore, is very great. The limits are not yet ascertained, with sufficient accuracy to define them; but the beds crop out on a belt of country, extending from near the mouth of the Scioto, in a N. NE. direction, nearly across the State. The beds, in some places, are too thin to be wrought with profit. In other localities, the ore is too much mingled with siliceous matter, or other impurities, to work well in the furnace by the ordinary mode of treatment. The beds of iron ore, in common with most of the rocks of Ohio, dip slightly to the E. and E. S.E., and lie one over the other, like the leaves of a book, so that they emerge in succession upon the surface. It is unnecessary to enter into any detail here, on this subject, as Professor Briggs, in his report on Jackson and part of Lawrence, and the adjoining counties, will give the necessary details. His report will tend to show the immense value of the future iron trade of Ohio, which may, at no distant day, rival South Wales, the great Coal and Iron district of Great Britain.

As the iron trade is beginning to be an important one in this State, it may not be inappropriate to make a few remarks upon the principles involved in the reduction of iron ores.

It has, always, been found to be an advantage to roast the ore previous to smelting, not only in consequence of the improved quality of the iron, but because an actual economy in the use of the combustible is effected. Some iron ores, containing more or less of sulphurets, make iron so inferior in quality as to be useless, but which, if roasted, and then exposed to the action of the air and rains, for a year or two before smelting, would make good iron. The cause of this is, that the sulphurets, arseniurets, &c., are disposed to chemical changes after roasting, and, when exposed to the weather, are converted into sulphates, arseniates, &c, which are dissolved and washed away by the rains. It is considered as an established fact, that iron ores are improved by exposure to the weather, so that they may make a purer and tougher iron.

Another object* in roasting the ores, is to render them porous, so that the carbonic oxide, (which, mixed with nitrogen, passes up through the body of the furnace,) may permeate the fragments, and deoxidize them.† If the fragments of ore were impermeable to the

* Another object still, is to make the ore more frangible, that it may be easily broken into fragments of a suitable size for smelting.

† The oxygen of the air, thrown into the furnace through the blast-pipe, combines with carbon, and forms carbonic acid, which, in contact with carbon at a high temperature, combines with another proportion of carbon, and forms carbonic oxide. We see the combustion of this gas in the blue flame of our fires, in which coke or charcoal is used. Carbonic acid is re-formed by this combustion.

carburetted gases, their surfaces only could be reduced. As the iron, when first reduced, is in the state of soft iron, it is infusible until it combines with a certain amount of carbon, and a long time would be required to reduce and melt the successive coats of iron on the surfaces of the fragments. In well regulated furnaces, the ore is broken to a suitable size; and each charge, after being introduced into the furnace, becomes reduced and carburetted in succession, so as to melt after the expiration of about the same time.

If the iron, as it melts, should fall down in naked globules of metal before the tuyere,‡ through which the blast is supplied, they would burn and be reoxidized; and in consequence, the oxide would flow off in the slag, giving it a black or green color. Thus, we see the necessity of conducting the smelting operation in such a way, as to have the globules of melted metal *covered with glass*, as they fall into the crucible of the furnace before the tuyere.*

This is one of the great objects of a flux. A flux is such a substance, or mixture of mineral substances, as will unite with the impurities of the ore to form a glass, which will coat over the metal as fast as it is reduced and ready to flow. It is necessary for the metallurgist, not only to have such a flux as shall combine with the impurities of the ore,† but that its fusibility be so proportioned as to melt at about the same time as the metal. Should it be too fusible, it would melt before the iron would be deoxidized, and dissolve the oxide, which would flow off in the slag, and besides, exercise a powerful solvent action on the boshes and crucible of the furnace. If a little less fusible, it would coat the reduced iron before it should become sufficiently carburetted, and thus prevent its becoming fusible. It would, in consequence, either clog the boshes, or form a salamander, as it is called, of semimalleable infusible iron, which frequently renders it necessary to tear away the lower part of the furnace, causing much loss of time and money. If the flux melt with too much difficulty, the melted iron falls naked before the tuyere, becomes reoxidized and passes off in the slag, which frequently clogs the furnace, and sometimes suspends its operations. Even if it should not clog the furnace, such globules of metal as were not burnt before the tuyere, would not sink through the semifluid cinder, but lodge in it, so that either no iron could be drawn from the crucible, or its usual quantity would be much diminished.

The uniformly successful prosecution of the reduction of ores, requires a combination of practical and scientific knowledge.

The study of metallurgy has been but little attended to in the United States, and there is no institution in our country where it is systematically taught. A School of Mines is very much needed in the United States. Several of the European Governments support such schools

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* Another object of fluxes, in the working of some varieties of ore, is to render refractory minerals, in the ore, fusible.

† Different iron ores, or else those from different localities, are mixed in the furnace, so that the impurities of the ores may flux with each other.

‡ Pronounced *twere*.

with a liberality commensurate with their importance. Our own country bids fair to draw as much wealth from her mineral treasures, as from the cultivation of the soil; and a School of Mines is highly necessary to facilitate the acquisition of such knowledge, as is indispensible for conducting mining and metallurgic operations.

Limestone.

Limestone is the most extensive deposit in the State. It is the rock nearest the surface, over about one-halt its area, and probably, underlies the whole at a greater or less depth. It is accessible, at no great depth, in many districts where no rock is visible at the surface. It is adapted, in different localities to various purposes, such as for lime, building stones and marbles. Localities will be indicated in the detailed reports It is believed that hydraulic cement may be made from some of our limestones.

The analysis of the limestones will soon be commenced, with a view to determine their adaptation to the manufacture of lime, and of hydraulic cement.

Limestone is, undoubtedly, the most valuable building material among the rocks of Ohio. Many of the beds yield a beautiful material, which is easily dressed. It stands the vicissitudes of our variable climate, and will endure unchanged for ages, in architectural structures.

The limestone district of Ohio has not been examined, except by a slight reconnoissance. In a scientific point of view, and perhaps in a practical one also, it does not yield in interest to any in the State. Lead ore (galena) has been found in many places in small quantities, and it is not improbable that valuable deposits of this mineral may be developed during the progress of the survey. Most of the lead mines of England, are in a limestone which is probably a geological equivalent to the extensive and thick limestone deposit of this State.

The fossil remains, which are found entombed in myriads in this rock, afford indubitable evidence that it once formed the bed of the ocean; and present a wide field for the investigation of the palaeontologist. It many localities, the most perfectly preserved specimens of these remains of ancient existence, can be procured in abundance, which will not yield in perfection and beauty to those from the most celebrated localities of Europe, or our own country.

Sandstone.

Sandstone is the predominating rock over a large part of the coal formation of the State. It is extensively used for building and for public works; for hearth stones in furnaces; for grindstones; and some of the fine grained stones of this class when homogeneous in their texture, are said to have been used for statuary purposes, and prefered by the sculptor to marble. Some of the varieties of this rock are very durable, showing sharp naked edges on the native cliffs, where

they have been exposed to the elements, during an unknown period of time. Where rocks, which are homogeneous in texture, disintegrate, they show rounded, instead of angular and sharp edged surfaces.

Rocks, unaffected by atmospheric agencies, will stand the test of time, and may be safely employed in public works.

The experience of this country during the past 30 years, has shown how necessary it is to make a proper selection of building materials for public edifices, and more particularly, for the Canal locks and aqueducts, where, by successive changes of wet and dry, and the action of frost, the stone is subjected to the most severe tests of durability. A rock for such purposes, should never be employed in construction, until it has been subjected to the most severe experimental tests. Different beds in the same quarry, often present great differences in their power of resisting the effects of heat and frost, and the chemical action of the atmospheric agents. The Engineer is, therefore, necessarily very cautious in the selection of the materials employed in public works, upon the construction and durability of which he relies for his reputation.

More details in regard to the sandstones examined this year, will be found in the reports of Dr. Hildreth and Prof. Briggs. In addition to these, may be mentioned the export of sandstone from near Cleveland for flagging, building, and for grindstones. Large quantities of this rock for the above purposes, and for columns, are sent to Michigan. The northern coast of Ohio seems destined to be the permanent source, from which the stone required in the Eastern parts of Michigan and the contiguous parts of Canada, will be drawn.

Clays.

Clay is very extensively distributed over the surface of the State, and will, probably, at no distant time, form an important branch of industry. Bricks are already extensively manufactured in some places. Some of the clays are adapted to making fire bricks, pottery, and glasshouse crucibles, and have been employed for such purposes. The localities of beds of clay, adapted for particular uses, will be made known in the detailed reports, during the progress of the survey.

Peat.

This is an alluvion, which is the result of vegetable decomposition. It varies in its aspect; the best quality is a soft, unctuous, tremulous mud when wet; but when dry, is so compact, as to receive a slight polish. When heated, it burns with flame and a bituminous odour. Ligneous, fibrous, and compact peat are the principal varieties: the two former are of comparatively little value; the latter is extensively used in France and Ireland, and is considered a valuable fuel. It is used, not only for domestic purposes, but also in burning lime, bricks, and pottery. In cold climates, it is formed in moist grounds and shallow ponds, wherever there is an accumulation of vegetable matter.

Decayed trees form a soft, light, spongy mass called ligneous peat: from decomposed grasses and reeds, a fibrous peat is formed, which is light and spongy, several feet below the surface; but at a greater depth it may be of good quality for fuel. Small aquatic plants and mosses, such as the sphagnum palustre, produce peat, which, at a moderute depth, is compact, without fibres, uniform in its texture, and of good quality.

Peat, although rarely seen in the southern, is very common in the northern parts of Ohio. On the Portage summit of the Ohio Canal it abounds, and, although this State is so abundantly supplied with coal and wood, yet peat may become a valuable fuel in those parts, which are remote from our Coal deposits.

SOILS.

The soils of Ohio are so rich, that many would suppose them scarcely capable of being rendered more productive. Art, however, is capable of improving many of them, so much as to double their produce.

As we are almost exclusively dependent upon the soil for those articles of food and raiment, necessary to the supply of our animal wants, and, as the annual products of the soil form the largest item in the increasing wealth of the State, it is deemed expedient to consider this subject with some attention. All the richest and most densely populated agricultural districts, are on the transition, secondary, tertiary and alluvial formations. Soils, with the exception of those resulting frsm alluvial *depositions*, are derived from the disintegration and decomposition of the subjacent materials, and they depend in a great degree, for their qualities, upon their mechanical and chemical constitution; hence, the geology of a territory is a necessary prerequisite in estimating the agricultural characters and value of its soils.

The variations in the productiveness of soils, are due to two general causes—viz.

1st. The mechanical texture of soils.

2d. Their chemical composition.

1st. The *texture* of a soil is a character of more importance than is generally supposed. To form a good soil, its texture should be such as to retain a suitable quantity of moisture for the nourishment of vegetation, and be neither so clayey as to bake and crack in the heat of the sun, or heave by the action of frost; nor so sandy as to become parched, and be mere dust at the depth, to which the roots of plants penetrate. Argillaceous soils have so strong an affinity for water, as to retain a small portion even when heated. There should be a sufficient quantity of clay in soils to enable them to retain 3 or 4 per cent of water when dry, and to convert the other materials into a loam. Perhaps a light loam, properly treated, produces the best crops.

It is also necessary to consider the substratum, in judging of the productiveness of any particular soil. If it be clay, or rock without fissures, the soil, however good in its texture and other qualities, will probably be "cold and wet." If the sub-soil be gravel or sand, the

surface soil is frequently too dry, unless it be a loam so heavy, as to retain a sufficient quantity of moisture for vegetation. Where a clay sub-soil occurs, it often alternates with beds of gravel and sand. Advantage may often be taken of this geological fact to drain wet soils, either by boring, or by sinking wells through the clay, into the gravel or sand below, so that the water will find an outlet in springs at a lower level, where these strata emerge on the sides of hills or ravines. In this way, stagnant ponds and marshes may be drained, not only so as to reclaim unproductive lands, but to render the surrounding country more healthful. These principles may be practically applied in many parts of Ohio.

However poor the texture of a soil, it can always be brought to a proper state of cultivation by art; but, unfortunately, the value of produce, and the price of labor will not often justify the expense. Light and heavy soils may always be benefitted by a proper admixture of clay or sand, as the case may require. That clay and sand are almost always associated, is a geological fact of much practical value in agriculture, as well as in the arts. The occurrence of one, (unless from the effect of some local cause,) is a pretty sure indication that the other may be found in the vicinity. Light dry soils are often injured by removing the small loose stones, which, instead of being an injury, are in reality an advantage, as they not only prevent the evaporation of moisture below the surface, by shading the ground; but, by their slow decomposition, furnish stimulants and food for vegetation, thus acting as a permanent manure.

2.—*Chemical composition of soils.*

The chemical as well as the mechanical composition of soils, exerts a powerful influence on vegetation. Salts, alkalies, and alkaline earths, act as stimulants if used moderately; but if in excess, they are injurious. Many soils contain calcareous rocks, stones, or pebbles, which are continually undergoing disintegration and solution by atmospherical agents; and thus serve as permanent mineral manures. Other soils abound in stones derived from such rocks as contain potassa as a constituent, and by their decomposition, furnish this alkali, in solution to the roots of plants, by which it is absorbed and carried into the circulation, and there acting as a stimulant, remains combined with some vegetable acid. The decomposition of gravel, pebbles and rock has been observed to be a benefit to vegetation; and as the rapidity of decomposition depends upon the surface exposed, it follows, that if such materials be ground fine and sowed upon the soil, like plaster of paris, a more decided benefit would be the result. This has been partially tried with success; and it is to be hoped, that the intelligent farmers of this State will give it a more thorough trial.

Iron, in some states of combination, exercises a beneficial influence on vegetation; yellowish and reddish soils almost always contain iron, and are generally productive.

Marls.

The value of marls for manure is well known. The term marl, in its strict mineralogical sense, means an argillaceous carbonate of lime, but by general usage, marl is an earthy mineral substance (or one which becomes earthy on exposure to the weather,) which, by being spread on the soil, renders it more fertile.

The principal varieties of marl, common in this country, are clay marls, shell marls, and the gray and green sandy marls. Clay marl, and the fresh-water shell-marl are common in Ohio, and these deposits will become valuable at no distant time.

A rock formation of great thickness, occupying a broad belt on the surface of the State, and undoubtedly underlying a large proportion of our territory, seems to be well adapted for use as a marl. It rapidly crumbles and disintegrates on exposure.

Fresh water shell marl is formed by molluscous animals, which secrete lime from the waters of the lakes and ponds, in which they live, to form their shells; and as generation succeeds generation, the dead shells accumulating, form thick and extensive beds of this material. When the pond or lake has shoaled to within a few feet of the usual water level, a growth of plants succeeds; and by an accumulation of vegetable matter, peat and "muck" are formed, and cover the marl. The peat and "muck" near the marl are filled with small fresh water shells, similar to those which have crumbled down to form the proper marl. The pure marl is a white crumbly mass when dry, but unctous and plastic when wet, and contains a few small white fresh water shells. If vinegar or any acid be poured on it, it effervesces briskly.

The value of fresh water shell marl is well known to some of our intelligent farmers; but few know it when they see it, and still fewer know in what situations to find it. For these reasons, I have particularized its characters and its situations. It performs the same office on the land as air-slaked lime, and is as valuable, while it has not the causticity to injure vegetation. One object in burning lime, is to reduce it to the state of powder by slaking. The shell marl is already in a pulverulent state, and only requires to be dug from the swamps and ponds and spread on the land.

The use of lime is extending very rapidly in New Jersey and Pennsylvania, and has nearly superseded plaster in some of the counties. "Individuals in the vicinity of Allentown, N. J., employ from 600 to 3000 bushels of lime, per year, according to the dimensions of their estates. It is carted from twenty to thirty miles in some instances. The quantity per acre varies from 30 to 100 bushels, according to the strength of the soil, the largest quantity being used where the land is richest in vegetable and animal mat er. The dressing is administered in from five to 12 years. Where the soil is thin it is necessary to plough in the lime the deepest. It is always added in the slaked

state, and generally in the fall of the year. After liming, a crop of buckwheat, oats, or corn is taken off previous to one of wheat."*

In Europe the lime is always allowed to air-slake before it is spread. Where lands are highly limed (and sometimes 200 bushels are used to the acre in England,) it is done only once in a term of twenty-one years. In some parts of France, a dressing of only 12 bushels is employed; and this is repeated every third year. Mr. Pulvis, who has done much in investigating the subject of calcareous manures, thinks this the least expensive and best; and as lime is so cheap, it must be an economical manure. "The advantage of the use of lime may be stated in a few words; it is an essential part of the seed of wheat, and that valuable grain will not grow in any soil which does not contain it."†

It may be well to remark, in this place, that limestones, containing magnesia, will not make a lime suitable for manure, however valuable it may be for cements. Farmers should be careful on this point, else they may fail in the use of lime, and infer that it is not adapted to their soil.

MINERAL SPRINGS.

The mineral springs called the Yellow Springs, and Delaware Springs, are extensively known and much frequented during the warm season of the year. Mineral springs are numerous in Ohio, and the slight investigations already made, may probably justify the conclusion that they may be found in almost every county. The springs at Cleveland and Medina and many other places, which it is not necessary to specify in this report, are more or less known, and have some celebrity in the cure of diseases.

The salt springs are the most important, and in the early settlement of the State, furnished most of the western country with salt, an article indispensible to the wants of civilized man. Before that time, salt was transported on the backs of pack horses, over the Alleghany Mountains, to supply the wants of the early settlers. The history of the Salt Manufacture will be found in Dr. Hildreth's report.

Petroleum Springs and Gas Springs are also numerous about the licks. A record of every locality of these springs should be preserved, and it is hoped that the people, who are acquainted with a thousand local details of the country around them, will communicate them freely to the several geologists engaged in the survey.

ALLUVIAL ACTION.

Action of Rivers.

Alluvial action is busy in effecting changes in almost every part of the State. Hills are in process of degradation, by the washing of rains, and by the sliding of avalanches of earth and rock. Streams are undermining and washing their banks, and depositing the materials

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* Shepard's Mineral Report of Conn., p. 115.
†Shepard's Min. Report of Conn., p. 116.

in parts more or less remote. A great variety of other causes are tending to change, in a degree, the relative elevation of land, and its geographical position. A few instances only will be given at this time in illustration of this fact.

The Muskingum, at Marietta, is supposed to be double the width that it was at the first settlement on the banks of that stream, in consequence of the trees having been cut down, the roots of which bound the fine loam together, and prevented its being washed away. At that time the bottom of the river is said to have been rock, but, in consequence of its increased breadth, by which the velocity of the current has been diminished, it has been filled up with gravel and sand to a depth of 12 feet. In freshes, the weight of the current of the Ohio is forced against the Marietta and Point Harmar shore. Fort Harmar once stood at some distance from the Ohio river, just below the Muskingum. A well, which was in the centre of the Garrison 40 years ago, is now on the bank of the river, and a part of the wall of the well has caved down with the bank. 100 yards in breadth, at least, must have been removed by the heavy sweep of the current against the bank in high water.

Another cause is tending to widen and shoal the river. The numerous steamboats in passing, throw up a succession of waves on the shore, which wash down more or less of the loam and sand, which are deposited in the eddies and still-water. The water along the shore is seen to be turbid with mud, after the passage of a boat, and it seems scarcely too large an estimate to suppose, that a ton of matter is, upon an average, swept from each bank and transported to other places from every mile in length, of the river, by the passage of every steamboat. If we consider the number of steamboats which daily pass, we shall see, that in a course of years, the effect resulting from this cause will influence the depth of water in some places so as to injure the navigation.

Degradation of the Lake coast.

At Fairport, the bank of the lake has been washed away to the extent of several rods in breadth within twenty years. The alluvial deposits of sand adjacent to the piers, covering an area of several acres, afford demonstrative evidence of the detrital matter having been swept along the shore, by the currents and oblique action of the surf. This detrital matter has, doubtless, been mostly derived from the encroachments of the lake on the adjacent coast. The alluvion, thus formed, is much more extensive on the west than on the east side of the pier. That on the west, is about two hundred yards broad. The transport is mostly from east to west. Near the mouth of the Chagrin river, the same effects are produced; but the destructive action of the surf to the west of the mouth of that stream, is more marked than on the east. The degradation here, during the last eight years, has amounted to a breadth of eight rods. Dr. Card, an old resident at Willoughby, has observed these effects on that part of the coast with much accuracy. There is

a stratum of yellowish clayey loam, to some distance below the surface, superimposed on blue clay, containing boulders, pebbles, and gravel.*

A shingle beach, derived from the boulders, pebbles, and gravel of the clay bed, skirts the base of the cliffs, and protects them from the surf, except during storms and high winds. The heavy N. W. winds drive the surf obliquely on the shore, and transport the sand and shingle to the eastward. A long spit has been formed across the valley of the Chagrin. But a few years ago the mouth of this stream was next the western terrace of the immediate valley of the river. The old mouth has been filled up, and a spit formed of several hundred yards in length. At this time, the mouth of the stream is next the *eastern* bench or terrace. The spit is continually extending eastward, and the stream necessarily cuts away the bank in that direction. The spit and the beaches are composed of sand and shingle, which offer a great protection to the coast; but the ever active surf is continually grinding them up by attrition. The transport at this place, is mostly from west to east.

The combined effects of the surf and land springs in the degradation of the coast, can be seen to advantage, at, and near Cleveland. The general level of the terrace above the lake is from 78 to 83 feet. It is composed of sand, gravel, and loam beds near the surface, sometimes fifty feet thick, in some places lying upon a buff coloured clay. These beds rest upon a deposit of lead-colored sandy clay, or clayey sand of unknown depth. Springs break out on the shore, at the junctions of these beds. These materials wash away very easily, and are borne off in suspension in the spring waters, while the superincumbent masses tumble down, forming ravines and valleys, which continually extend further inland, with lateral branches spreading more and more widely. The hill by the bridge from Ohio City to Cleveland, indicated this kind of action during the past summer; and a small spring of water was silently, and almost without attracting observation, performing more in transporting materials from a higher to a lower level, than the efforts of several men could have accomplished. The bed of the Cuyahoga river is rapidly shoaling, from this cause. The coarse sand forms a bank in the river, as steep as this material can lie in water, and projecting out, like deltas at the mouths of large rivers. This shoaling action will, eventually, either dam up the river and form stagnant water above, or else force it to cut a new channel.

At Cleveland, much earth has been, and stlll is washing down by land springs, and it is only by the exercise of much skill and ingenuity, that some parts have been preserved from gullying out, and undermining the streets of the city.

The shore at Cleveland is washing away rapidly in front of the town. A reference to fig. 2, of the plate will illustrate this mode of

* The boulders and pebbles, enclosed in the clay, are more or less smoothed as if by attrition; and many of them are distinctly scratched, as if dragged in a fixed position over hard rocky surfaces. Specimens are preserved. They were not picked up on the beach, but dug out of the clay itself, where they had lain undisturbed since their original deposition. They consist mostly of granite, and a hard compact blue limestone.

action. The cliffs, undermined by the surf and land springs, crack off at the top and slide partly down, so as come within the action of the surf, while other slides from above, continue to push it farther and farther into the Lake, until all is carried away by the waves and shore currents. Slides occur every year. Several rods, in width, have slidden down and been washed away, within a few years.

Attempts have been made to arrest this degradation, which threatens to remove the site of the city in the course of a century or two, unless it be checked. If piers be erected at intervals, extending out for 100 to 150 yards from the shore, and well filled in, alluvial deposits from the sand swept coastwise by the surf and shore currents, will necessarily be deposited in the eddies formed by these obstructions. An example of the application of this principle may be seen on the West side of the pier which protects the harbor, where several acres of alluvial land have been formed within four years. As the coast *West* of Cleveland is rock-bound, very little detrital matter is swept eastward, while the coast to the east of Cleveland, to Fairport, composed of earthy materials, is mostly in a state of rapid degradation. The northeast winds sweep this detrital matter along to the westward, and deposit it behind the obstacles which create eddy currents. The long pier at Cleveland has caused such currents, and the deposit of the alluvial sands just mentioned.

One evidence that the Lake has been making encroachments on this part of the coast for a long time, is an isolated hillock, a part of the original shore, which was also the boundary of a bluff on the Cuyahoga river. This bluff turned the river westward, so that its mouth was a mile or more West of Cleveland, and remaining without degradation on the river side (as is evident by its moderate slope,) was washed away on the Lake shore, until it was cut through at the bend, and gave the river a shorter course to the Lake through a new mouth. The old mouth is closed by a sand beach, and the alluvial ground mentioned as having been formed West of Cleveland, is partly in front of the hillock, which presents a nearly vertical escarpment towards the Lake.*

The evidence of the degradation of land by the surf on the shore, may be seen at any time by standing on the cliff at Cleveland (and at many other points on the coast,) and looking off upon the Lake. At the distance of one-half to one mile from the shore, a distinct line may be seen to mark the division between the muddy water, produced by the washing away of clay and the grinding up of pebbles on the coast, and the clear blue water of the Lake. All the water between that line and the shore is tinged with finely divided matter in a state of suspension. This matter settles in still water, and, probably, forms clay on the bottom of the Lake, imbedding shells and other organic remains.

From the facts which have been mentioned in relation to the alluvial

* The topographical map of Cleveland, vide fig. 1, of the plate, indicates the old and new mouths of the river; and the new mouth is now filled up, in consequence of the river being confined between the piers.

action on the coast, it will be seen that the direction of transport is sometimes eastwardly and sometimes westwardly. This is dependent upon local causes, such as the trend of the particular line of coast, the prevailing direction of winds, the angle at which the surf rushes to the shore, the direction of eddy currents, and the peculiar position of parts of the coast, which are washing away. From the facts which have been mentioned, it is believed that the aggregate amount transported from East to West is greater than in the opposite direction. One fact, especially, gives weight to this deduction, viz., the prevailing strong winds, which affect the South coast of Lake Erie, are from the N. E. to N. W. The winds from the latter direction throw the surf nearly perpendicularly upon the shore, so as to grind up the shingle, and undermine the cliffs, without causing distant transport, while those from the former direction roll the heavy waves obliquely along the shore, producing currents, which, together with the surf, transport the materials from place to place, and deposit them in sheltered situations.

It is stated, that the coast of Lake Erie is undergoing a more rapid degradation by the action of the waves, than it did in former years, and the reputed cause, is, that a dam partly across the outlet between Buffalo and Black Rock, obstructs, in some degree, the drainage of the Lake. Any obstacle at the outlet, which checks the rapidity of the current, must obstruct the drainage, and, in consequence, the level of the Lake must necessarily rise, until the escape of water, by drainage and evaporation, shall equal the supply. The rise of water exposes that portion of our coast, where it is not rock-bound, to inroads from the Lake by overflows, or to more rapid degradation by the waves.

The owners of the dam at the outlet of the Lake, must necessarily be liable for such damages sustained by our citizens on the coast, as result from the obstruction referred to. Data are being collected, by means of which the relative amount of degradation for distinct periods of time, in particular localities, may be estimated.

Analysis of Coal and Ores.

The analysis of the coal and iron ores, the localities of which were examined during the last season, will be soon commenced, with a view to ascertain their adaptation to the manufacture of iron. Although iron is smelted so extensively in England, by means of bituminous coal, and the coke obtained by charring it, it is believed that only three furnaces are operating with these combustibles in the United States, and two of these are in Ohio.

It is believed that there are many coal beds in Ohio of a quality suitable for smelting iron ores. Chemical analysis will ascertain the probability of their adaptation to the purpose; still, as as matter of prudence, works should not be erected until a successful trial of the coal and ore has been made.*

* Coke is now manufactured in Ohio from several of the coal beds. Hon. Daniel Upson, of Portage County, makes a coke of excellent quality from the coal of his mine in Tallmadge Mixed with charcoal, it is used in the high furnace at Akron, in the smelting of iron ore. Mr

If our coals should prove to be pure enough for smelting iron, Ohio has the elements of unbounded wealth beneath her soil, and she may become the most productive iron district in the world.

Importance of determining the Dip.

The dip, or the angle by which the planes of the strata plunge below the horizontal plane, is so small in most parts of this State, that the determination of its approximative amount becomes an important element in the determination of the subterranean value of our lands. Important mineral beds, such as coal, iron ore, limestone, &c.; although they may not show themselves on the surface of the earth, even in the deepest valleys of a particular district, may yet lie so near, as to be capable of profitable exploration; hence, the determination of the mean dip of the strata is an indispensable datum in determining whether they lie at such a depth as to be valuable. The strata dip so slightly, that beds of moderate thickness occupy a belt of considerable breadth; and in the direction of their dip, such as are valuable, may be explored with profit, at a distance of many miles from the place where they form the surface.

There are various means of determining the amount of mean dip over extensive tracts of country, all of which will be employed, and serve as checks to each other. Instruments have been procured, by means of which the exact amount of local, as well as the general dip, will be observed, in as many places, as may be thought proper, and the faults and undulations, although not visible on the surface, may be ascertained, if they exist. The Topographer of the Geological Survey, Colonel C. Whittlesey, has obtained the levels of a great number of points, by consulting the records of the Board of Public Works, and the various surveys for the internal improvements in the State. Many others will necessarily be determined by his own observations in the discharge of his appropriate duties. The determination of the various levels has many important practical bearings, and there is one which will be, ultimately, of much scientific interest. Elevatory movements have taken place on almost every part of the earth's surface at different periods. Some of them have occurred within the historical epoch, and even now, Sweden is said to be gradually rising above the level of the Baltic sea.

These levels above the ocean, will be standards of reference, which will determine whether such effects are now in progress.

Organization, Duties, and Estimates.

The geological corps has been organized upon the basis of the act of the 27th March, 1837, with the intention of developing the natural resources of Ohio, and furnishing complete catalogues and descriptions

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Ford, of Akron, by mixing 40 bushels of coke per day with the charcoal, is stated to have increased the quantity of iron smelted 33 1-3 per cent. The coal bed is from 3 to 5 feet thick, and from 2 to 3 feet of the coal makes excellent coke, which is found to be a perfect substitute for anthracite coal in the cupola furnaces.

The time cannot be far distant when our iron masters, like those of Great Britain, will depend exclusively on this combustible for smelting.

of all her natural objects. It is proposed, also, to make a comprehensive *collection* of the natural productions, so as to exhibit under one roof complete suites of specimens of the animal, vegetable, and mineral kingdoms.

With a view to a perfect and rapid accomplishment of the varied duties of the survey, several distinct departments have been created, appointments made, and to each individual an appropriate sphere of duty has been assigned.

Dr. S. P. Hildreth of Marietta, who has been long engaged in investigating the fossil remains and the geology of the rocks of Ohio, was appointed as first assistant, and directed to take charge of a department, embracing the description and figuring of the organic remains found entombed in our rocks.

It was deemed expedient to have a *palæontologist* engaged in the geological survey of the State. All the branches of natural history and many of the other sciences, cluster around geology, and lend to it, and to each other a mutual support. No man can make great advances in *all* the branches of geology; the proper course to be pursued, is for each individual to become acquainted with the great outlines of the subject, and then devote his attention to some particular branch of enquiry. It is by such a division of labor, that geology has advanced so rapidly within a few years. Physical geology and palæontology are distinct branches of enquiry. The palæontologist must, necessarily, be minutely familiar with the various branches of natural history, to distinguish the minute shades of difference in the species of fossils, and consult many authors to know what has been described and figured by others. The geologist must have the *results* of such labors, before he can draw definite conclusions on some points of geology. It is believed that this division of labor will facilitate the perfection of the work, by enabling each individual to devote more attention to his specific branch of enquiry.

Dr. Hildreth, in consequence of his infirm health rendering it impossible to discharge the laborious duties of his department of the survey, is about to resign. I may here be allowed to render a tribute to this gentleman who has been a resident of Ohio for nearly half a century, and for many years been ardently devoted to geological investigations in this section of our country. He has published several geological and other papers, which are valuable both on account of the economical and scientific facts which they contain. He saw the prospective value of the mineral beds of our territory, and exerted himself to procure an act authorizing the geological survey of the State.

It is intended to avoid all discussion involving theories and theoretical considerations, in the *annual reports*. They are intended to be entirely of a practical character, containing statements of facts, developments of our mineral resources, and such information as may aid our citizens in applying the mineral wealth of the State to practical purposes. In consequence of Dr. Hildreth being about to resign from the geological corps, some theoretical deductions, to which he has arrived, are contained in his report; but in general, such discussions are to be

retained for publication in the final report after the conclusion of the survey; when, it is believed, such masses of facts will have been accumulated, as to leave less chance of error, than if deductions were made from the results of each year's examination.

The buhrstone, termed by Dr. Hildreth the calcareo-silicious rock, is an important mineral deposit, and it involves as much of scientific interest in its mode of formation, and the contained fossils, as in its useful applications. Dr. Hildreth has described the members of the coal series which lie above the buhrstone.

The history of the Salines of the State, and numerous facts in relation to them, are contained in his report, and will be read with much interest by all.

Dr. J. P. Kirtland, of Poland, now of the Ohio Medical College, at Cincinnati, was appointed the second assistant, and directed to take charge of the department of Botany and Zoology, which involves a description, and the completion of catalogues, of all the living organic matter of the State. It embraces the development of the best modes of culture, of improving our stock, of obviating the destructive influence of the blight, mildew, and insects, and a great variety of topics, which are not only of interest to science, but of high practical importance. By a knowledge of the habits of insects and animals, it can scarcely be doubted, that the farmer might be secured in the enjoyment of the fruits of his labor, where he now frequently laments over his ruined harvests.

Dr. Locke, the 3d assistant, was in Europe at the time of his appointment, and did not return until the field duties of the season were about to close. He has not, therefore, performed any duty on the Geological survey.

Professor Briggs, the 4th assistant, assisted by J. W. Foster, Esq., of Zanesville, entered upon his duties in July last. These gentlemen were actively engaged in the field duties of the Geological Survey until the 20th of November. Mr. Foster was appointed as an acting assistant, and associated with Prof. Briggs in the survey of the district lying between the waters of the Scioto and Great Hockhocking.

Col. Charles Whittlesey, of Cleveland, was appointed to take charge of the Topographical Department of the survey, and has been actively engaged in the numerous and laborious duties of his office. He has furnished skeleton maps of townships and counties to the Geologists proper, and collected all accessible information from the Land offices and public records, in relation to the boundaries of counties, towns, courses of streams, &c., preparatory to the construction of a topographical map of the State.

The amount of information thus obtained, is much less than it was supposed could be procured from these sources, the reason of which is fully detailed in Col. Whittlesey's report.

The topographical map of the State, if accurately constructed, will indicate the whole contour of the ground, and the physical character of the country, as if it were actually spread before the eye of the observer, showing, at a glance, its plains and mountains, hills,

valleys, streams, bottom lands, swamps, marshes, woods and cultivated fields.

On such maps, the localities of all minerals, ores, rocks, &c., can be indicated in their proper position and relations to each other.

The great objections to our present maps are, that a level country is indicated where it is a labyrinth of hills; that boundaries of townships and counties are often erroneous; and streams are indicated far from the positions where they actually flow.

An accurate topographical map would require a triangulation similar to that of the national coast survey, which has been in progress for some years. The time and expense of accomplishing such a survey would be greater than the Legislature would, probably, deem expedient to appropriate for its completion. Such a survey, however, once accomplished, would never again be necessary. The importance of such a map, for a multitude of purposes, besides its basis for a geological map, is well known.

The appropriation for the continuance of the survey, must determine whether the topographical department be conducted upon the principle of accurate triangulation, or adopting the divisions of counties, townships, sections, &c., as bases, and filling up, by slight admeasurements, and sketches by a *coup d'oeil*. A *trigonometrical* survey of the State would require an expenditure, of at least $100,000 for its completion.

In conformity with the spirit of the act authorizing the Geological Survey, the Topographer, Col. Whittlesey, has been instructed to survey the remains of ancient works, which are so numerous within our territory. The plans and descriptions of these works will be given in the final report. Col. Whittlesey's slight notice of some of these will be found in his report, which is annexed.

In addition to my proper sphere of duties, of superintending the survey, and visiting the more important localities, the department of chemical analysis will be conducted by myself, and under my immediate supervision. Ores, mineral waters, coals, and all mineral substances, will be analyzed, if there be a probability that they may be capable of useful applications.

As the primary object with the Legislature, in authorizing the Geological Survey of the State, was to develop its natural resources, with a view to their application to the economical purposes of life, it is, of course, an object to have it accomplished at as early a day, as is consistent with its proper execution. It is, therefore, respectfully suggested, whether it be not expedient to so modify the act, authorizing the survey, that a greater number of individuals may be employed in its different departments.

If the corps be increased, so as to give one more assistant to the survey, and the Geologist authorized to employ, temporarily, such individuals as may be necessary for local purposes, the expense will be but little increased, while the number of persons employed, and the amount of labor accomplished, will be more than doubled. There are numbers of our young men who might be usefully employed in this

enterprise, and with a small compensation, would engage in such duties, merely with a view of acquiring practical knowledge.

I consider it a duty to make the above suggestion, as the total amount necessary for the accomplishment of the work, will be less, while our citizens can be reaping the benefit at an earlier day.

If the present organization be continued, as under the existing act, the necessary appropriation for the current year will be $12,000.

If the suggestion, above mentioned, for increasing the corps, and employing acting assistants, be adopted, it will be necessary to in-increase the appropriation for the current year to $16,000.

If the topographical survey of the State be continued, as at present, no expense above the appropriation mentioned, will be incurred; but if the State be *triangulated*, for the topographical survey, the appropriation for the current year, should be $30,000.

I have the honor to be, sir,

Your obedient servant,

W. W. MATHER,

Principal Geologist of Ohio.

REPORT

OF

DR. S. P. HILDRETH,

FIRST ASSISTANT GEOLOGIST.

No. 2.

To Professor W. W. Mather,
Principal Geologist of the State of Ohio.

Sir: The most favorable portion of the season for field operations being considerably advanced before the corps for the geological survey of the State could be organized, the results of individual observation cannot be so great, as they otherwise might have been. Our researches have been wholly confined to the coal measures; and of this district only a part has been examined. It embraces all the south eastern, and north eastern sections of the State, and abounds in minerals, the most important of which are coal, salt, and iron ores. It also contains valuable deposits of quartz rock, marl, lime-stone, clays, and a great variety of fine and coarse grained sand rocks, for architectural and other useful purposes. Through the whole of this region, the rock strata are arranged in regular series, and the different beds so placed, as to be the one subordinate to another, over large extents of surface. And although to the eye of the casual observer, they may seem to be in the utmost confusion, yet the greatest regularity prevails in the arrangement of the different deposits.

So far as this State is concerned, and it contains but a small part of the coal measures of the valley of the Ohio, the rock strata appear to have been but little disturbed since their original deposition from the ocean of waters, that once covered the whole valley between the Rocky and Appalachian ranges of mountains. There is a general, but gradual dip of all the strata towards the centre of the valley; so that, on the western border, the dip is easterly; on the northern, southerly, and so on, with great regularity, until we approach the more mountainous portions, when this order is broken in upon, and the inclination is acommodated to the ranges

of mountains, which have evidently been raised at a period posterior to the deposition of the coal measures.

The regularity in the dip, and moderate inclination of the strata, afford facilities to the miner, not known to those of most other countries, especially, in Great Britain, where the coal not only lies at great depths below the surface, at a high inclination, but the strata, in which it is imbedded, have been broken and thrown out of place, since their deposit, occasioning *slips* or *faults* of many feet, sometimes of several hundred; causing much labor and expense in again recovering the bed, which is to be sought either above or below the spot cut across by the *fault*. In the coal beds of Ohio, very little difficulty of this kind is experienced. *Faults* or *slips* of a few inches or a few feet, are sometimes met with, which have been occasioned by slides or the gradual settling of the earth from the undermining of the hill sides by water courses, or springs, rather than from any force from below.

The ease and facility with which coal is mined in the west, where the beds are generally opened at the base, or in the side of a hill, in the coal itself, and drifts carried under horizontally, will be better shown by contrasting it with the process of mining in Great Britain.

In Northumberland, the Newcastle coals, which are most familiar to us, are brought up from great depth, and at a heavy expense, by sinking *shafts* or *pits*. Steam engines are used for raising the coal and freeing the mines from water at this place. The upper, or *main bed* lies at 450 feet, and is six feet in thickness. The *lower main* lies at 810 feet, and is 6½ feet. Between these two there are eight thinner beds, one of 4, and one of 3 feet; the rest quite thin. In the whole, there are 40 distinct beds in this coal field, which is 58 miles in length, and 24 miles in its greatest width. In all these beds they count on 30 feet of workable coal. They have many other smaller fields in different parts of the island.

In Somersetshire, some of the shafts have been sunk to the depth of 1,200 feet. The beds here are from eighteen inches to nine feet in thickness, and 23 in number, making 95 feet of workable coal, over a space of 100 square miles.

In Staffordshire, at 360 feet, they find a bed of coal that is 27 feet thick. It is, however, divided into several portions by thin seams of slate clay. These beds are highly inclined at an angle of from 10 to 45 degrees, so that in a few miles they sink to a great depth. Similar deposits of argillaceous iron ores, accompany the coal as in Ohio, and furnish nearly all the iron manufactured in England. The rocks which lie over the coal are generally much less inclined, and sometimes nearly horizontal. They are new red sand-stone, lias, oolite, &c. The two latter are rocks, which have been very partially, or more probably, not deposited at all over the coal measures of Ohio.

That portion of the coal measures of the valley, which lies within this State, occupies a space of about 180 miles in length, by 80 in breadth; extending in a south westerly and north easterly direction along the border of the Ohio, from Trumbull county to the mouth of the Scioto. These immense fields will furnish fuel for a larger population than the soil of Ohio can support for ages; and when the surface beds are exhausted, much thicker ones will be found by sinking shafts to the depth of a few hundred feet, as all coal beds are thinner in their out-crop, or near their margins, than in the center of the basin. Of this fact we have proof, not only from foreign fields, but from the disclosures made in boring salt wells in our own State.

Although a considerable portion of Ohio is hilly and broken, yet we have no mountain ranges, and our hills are hills of degradation, or made by the wasting away of the original rock strata and earth by the continued action of rains, frosts and running waters, in the course of unknown ages. That there was once a period, when the valleys between the hills were all united and in juxta-position, is made evident from the fact of coal beds, sand rocks, &c., which are found at a certain elevation in the hills on one side of a valley, being also found at the same, or nearly the same height on the opposite side, although the distance between may be more than a mile; as may be witnessed at many localities on the Ohio river, or any of the smaller streams.

It is probable, that the larger portion of this cutting, or wasting process, was accomplished soon after the receding of the oceanic waters, and before the earth was clothed with the present families of forest trees; and while yet in the vicinity of large bodies of water, the climate was probably more humid and milder than at this time, affording a much larger annual amount of rain similar to that of tropical climates in the present era of the earth. From the fact of the lower series of rock strata, which compose the coal measures, terminating on the outer margin of the basin in heavy masses and abrupt precipices, as in the vicinity of Lancaster, in Fairfield county, and several other places near the borders of the great lime-stone formations, which occupy the middle and western portions of Ohio, and being also indented, similar to the bays and head-lands of a modern sea coast, we are led to conclude that the coal measures were gradually raised by successive depositions on the bed of a sea, and formed an island or islands on the borders of the ocean which then covered the larger portion of the valley of the Mississippi. We are led to draw this inference from the fact that no boulders, or erratic blocks are found far within the present coal measures, but only on their northern or western borders, while the surface of the prairies and the country west of the coal series is profusely dotted with these fragments of a primitive formation. The most plausible theory of their origin is that of their having been brought by currents from the north, imbedded in ice, at a period anterior to the formation of the Allegheny ranges of mountains, when the present "Gulf stream" flowed over the regions which now compose the western states. These floating masses of ice and earth, meeting with the warmer currents of the south, gradually melted and deposited the imbedded fragments on the bottom of the ocean, in the same manner that the icebergs of the present day are scattering the ruins of the north over the banks of Newfoundland, and the latitudes yet further south.

From Lake Superior to the coast of Florida, there is to be found in the rock strata, every evidence we could ask in countless millions of the reliquiæ of oceanic life, that a sea once covered all the rigion now watered by the tributaries of the Mississippi. The strata which compose the coal series have been deposited from water. Some of them, especially the slate clays, apparently from a quiet medium, while the sand-stones and coarse conglomerates, bear in their structure evident marks of having been thrown down from a moderate current, or one of greater rapidity, according to the size of the component particles. Where the vertical face of a deposit is fairly exposed, as in the sides of large grottoes, their wave-like structure is beautifully shewn; in some localities imitating the appearance on the bed of a stream, and pointing out, by the arrangement of the particles of sand and mica, the course from which the waters flowed. These are all formed from the detritus of other and older rocks; having in their

composition, mica, quartz, feldspar, &c. From the disintegration of the primitive and transition series, in a coarse or more finely comminuted state, the present secondary rocks are constructed; the particles being generally cemented either by calcareous or argillaceous matter. In some instances, the uniting material is silicious and ferruginous, when an exceedingly hard rock is the result.

How far these views of the original condition of the coal measures, and the formations west and north of them, can be supported, must depend on the discoveries yet to be made in pursuing the geology of Ohio, which is only in its incipient state.

With these preliminary remarks, we will now proceed to a more particular description of the rock strata of the eastern part of the district of country traversed in my researches as "Palæcontologist, and assistant Geologist;" my more especial duties being to collect, describe and arrange the fossil organic remains, both of a vegetable and animal origin, that may be found in the State. While on these tours, it has been a leading object to trace out the direction and extent of the great quartz deposit, or calcareo-silicious rock, which, like a zone, encircles a large portion of the width of the State, and discover the muriatiferous or salt producing rocks, and also the main ferruginous deposits. It is one of the most interesting features in the geology of the coal measures of Ohio, and, like the meridian line in geography, will afford a valuable guide in developing the series of rock strata which lie beneath, or are superimposed on this deposit. The early history of the salt manufacture, as intimately connected, not only with the geology, but with the vital prosperity of the State, will also receive such notice as my present limited store of facts can afford. The descriptions of the fossil organic remains will be chiefly deferred, until the final report of the survey.

Description of the rock strata which lie over the "Buhr-stone" or calcareo-silicious rock, on the west side of the upper coal measures.

Mr. Briggs, in his report, having described the rock strata which lie below the calcareo-silicious deposits in the lower part of the coal measures, I shall enumerate those which lie above it, as they were noticed in my explorations on the west side of the Muskingum river, in the counties of Meigs, Athens, Perry, Muskingum, Morgan and Washington.

This enumeration will nearly complete the series of the coal measures, terminating with those, which are the most recent near the central part of the basin on the Ohio river. For the convenience of description only, they are arranged in numerical order, subject to such alteration hereafter, as the more minute and detailed surveys may discover to be necessary, and will probably be needed. The principal object of this description of strata, being to give a tabular view of the order of arrangement in the series above the Buhr-stone deposits.

From the undulating position of the rocks in some places, the dip of the strata varies, very considerably, even in short distances; presenting, in this respect, the difference of from 10 to 50 feet in a mile, but the general inclination of the whole, on the western side of the basin, is to the east and south east.

No. 1.—*Calcareo-silicious deposit, or Buhr-stone rock.*

This being one of the most interesting members of the series, and serving as a guide to the deposits above or below it, independent of its great

value for economical purposes, will receive more notice than any other rock. Its external and most common appearance, as a silicious or quartz rock, is so peculiar as to be readily recognized by most observers; and where it assumes its calcareous character, as it does in many places, it may be known by the imbedded fossils which accompany this rock in its whole course.

Range and extent.

In its range, this deposit embraces all the western borders of the coal measures in its out crop on the hills extending from the Ohio river in a north, and slightly east direction, to Stark county; beyond which, northeasterly, it has not been traced. Its average breadth may be estimated from 12 to 15 miles; widening out in some places to 20 miles, which will include its extreme westerly outliers on the hills, to its easterly dip, or disappearance below the beds of the rivers and creeks.

In travelling westerly from the mouth of the Muskingum river, we first meet with this rock on the west side of Alexander township, in Athens county. It is here seen in the left bank of Margaret's creek, just below Mr. Toppin's mill, about seven miles in a south west direction from the town of Athens. The deposit is six feet in thickness, where it appears to view, but is probably thicker, if it were uncovered. It lies in layers or beds of from six to ten inches in thickness. The color of the rock is dark grey, and holds a large share of lime in its composition, as is the fact at many other localities farther west. When removed from the quarry, as it frequently is, by the inhabitants of the vicinity, from other beds besides this, for underpinning their houses, laying cellar walls, &c., it is often found ready split to their hands, in parallelogram and prismatic pieces, with smooth, plane faces, suitable for window sills and caps, or building up in a wall without any additional dressing, except to square occasionally a rough extremity. The same deposit is exposed in the beds of the streams for several miles west, in the township of Lee. At this locality, a bed of loose sand-stone lies over the calcareo-silicious rock, and a dark shaly stone beneath it. At some localities further west, a bed of coal is found a few feet below; and still further west, it rests immediately on the coal. The rock at Toppin's mill contains the characteristic fossils peculiar to this deposit, such as encrini, producti, spiriferi, terebratulæ, &c. In travelling westerly, in Lee and Brown townships, loose and broken fragments of the rock are discovered in the beds of runs, and occasionally it is seen to crop out in places on the sides and points of hills. On section No. 16, in Lee, near the house of Judge Warner, it crops out by the side of the road, where the water from a spring has laid it bare. Here it is 8 feet in thickness, lying in regular strata of 8 or 10 inches. It contains a considerable portion of lime in some of the upper layers, while the lower are nearly pure quartz and horn-stone. The color is various, from brown to black, green, blue and horn color. The cross fracture is conchoidal, while the division by stratification is into plane surfaces. The lower bed, where it approaches the coal, is nearly black. Near the top of the bed some portions assume that open cellular structure which renders it so valuable a material in the manufacture of mill-stones. This peculiar feature in its character, however, so far as I have observed, is chiefly confined to that portion of the deposit which lies within a few miles of its western limits. West of Lee, in the northern part of Brown township, the calcareo-silicious rock crops out at a gap in a high ridge, and large fragments of the compact quartz are scattered over the surface.

Where it appears in the heads of branches, it has not assumed the texture of buhr-stone. It is, however, so seldom seen in large beds until it reaches Elk township, that it is difficult to decide on what may be its true character, until quarries are opened extensively. In the south west corner of Brown, are some beds of buhr-stone that appear to be equal in quality to those farther west. In Elk, which is 24 miles south westerly from the town of Athens, many valuable quarries of mill-stone rock are opened; some of them have been worked since the year 1807.

In Richland township, Jackson county, the buhr-stone is found 8 miles west of McArthurstown. It appears to terminate on the west side of this township, on the tops of the hills, and has been the uppermost stratum for several miles east of this point. Here it assumes a different texture. The quartzy portion has evidently been broken into fragments, which have the appearance of being water-worn like pebbles on a beach, and afterwards cemented by sand and iron similar to a conglomerate or pudding-stone.

This locality is near Mr. Redfearn's, on an easterly branch of the middle fork of Salt creek. Near the western termination of the calcareo-silicious deposits, the coal which lies a number of feet below it in Lee, has approached to within a foot or two, and in some localities, is directly under it. The coarse sand-rock over it is, in some places, entirely wasted away, or run out, while in others it has crumbled into a bed of sand. The buhr-stone is seen in nearly all the hill sides for many miles from below the elevation, where it is in situ, to near the bottoms of the hills, having gradually slidden down with the earth in the course of ages; and being of an imperishable quality, it remains, while other rocks are decomposed and washed away. To the north west of Richland, this deposit is traced on to the heads of the Raccoon creek and the Honey fork of Queer creek, in Hocking county, while to the south it continues on in rich beds of buhr-stone for 12 or 14 miles in length, by 6 or 8 in breadth. On the east side of Jackson county, in the townships of Milton and Bloomfield, the calcareo-silicious rock is found dipping gradually down to the base of the hills; and near the middle of Wilkes township, in Gallia county, by the bridge which crosses Raccoon creek, it lies only a few feet above the bed of the stream. This locality is 4 miles west of the village of Wilkesville. To the east of this line, it appears no more above the water courses. The hills rise over it, and the bed of no stream east has been cut to a sufficient depth in the superincumbent strata to bring it to light, but it is passed at very considerable depths on Leading creek and Chickamoga, in boring for salt water. South of this place, the out crop of this deposit takes a more south-westerly direction, while the course for 12 or 15 miles north of this, has been very nearly north and south. Still pursuing a south westerly line, it crosses the westerly extremity of Gallia county, and is found in abundance on the head of Symmes creek, in Lawrence, and from thence to the Ohio river. In tracing the line of bearing in a north easterly direction from Jackson county, we find this rock cropping out on the hills on the eastern side of Hocking county, and the corner of Athens, in York township. In the latter township, it is quite silicious in its character, and were it more cellular, is sufficiently hard for mill-stones. It is regularly stratified in a bed of 8 or 9 feet in thickness, on sections 9 and 14, in town 12, range 16. The same coarse sand-rock lies over it, as in Jackson county. The farthest west where the quartz was seen in Hocking county, is in range 16, town 12, section 4, in Swan township. North of this, it is found only in detached fragments lying on

the tops of the ridges, which can only be explained from the preponderance of lime in its composition over this region, which, having decomposed in the course of ages, has left but few relics of its existence as a regular deposit. The same remarks may be applied to the country on the east side of the Hockhocking river, where detached fragments only can be found until we reach the north east corner of Green township. Here; and in Monday creek township, it is occasionally seen in place near the tops of the hills, and in fragments amongst the debris in the beds of the streams. As we progress northerly in Perry county, it becomes more abundant; and at Lexington, in Pike township, the calcareo-silicious rock is seen in continuous masses, lying on a level with the present alluvions of Rush creek. It is here nearly pure quartz, and has not wasted away by the action of the elements, being in a manner imperishable. This enduring quality has enabled it to maintain its present position, while the softer, underlying rocks have disappeared, by the wearing action of the stream. It is so compact and silicious as to have attracted the notice of the aborigines, who have manufactured it largely into arrow heads; if we may be allowed to judge from the numerous circular excavations which have been made in mining the rock, and the piles of chipped quartz lying on the surface. From thence northerly, it may be traced across the length of the county, bearing north easterly into the corners of Licking and Muskingum counties. Here it lies on the tops of the hills for many miles in extent, forming what is called "Flint Ridge," a locality well known to that region of country. In the two townships of Hopewell, it lies on the surface in extensive masses, and has been an object of peculiar interest, both to the aboriginal and present inhabitants of the country. To the former, from the most remote periods, it has furnished a valuable material for the manufacture of knives, spear and arrow heads. How extensively it has been worked for these purposes, may be imagined from the countless number of excavations and pits yet remaining, from whence they dug the quartz; experience having taught them that the rock recently dug from the earth, could be split with much more freedom than that which had lain exposed to the weather. These excavations are found the whole length of its out crop, from Jackson to Muskingum, but the most abundantly on "Flint Ridge," from its furnishing a more compact quartz, and greatly diversified with rich colors. To the present inhabitants it is valuable as furnishing a fine article for mill-stones, as will be more especially noticed in the remarks on that subject.

The buhr-stone in Muskingum county, assumes a different aspect from that in Jackson. The color is lighter, and the cells differently formed. Instead of open fissures, the portions selected for mill-stones, are filled with small, tortuous, vermicular passages, about the sixteenth of an inch in diameter, which, to the naked eye, appear to have been formed by an aquatic worm traversing the mass while in a soft and plastic state, but which, on a more minute examination with a microscope, prove to be the matrices or cells of a small, fusiform, univalve shell, of a genus very similar to rostellaria, but whose species is not yet determined. These, with occasional small joints of encrini, make up the great mass of minute cells which cover the face of a fresh broken fragment of the burrstone. Occasional specimens of terebratulæ, spiriferi, producti, &c. are seen in the silicious portions of the rock, but they are comparatively rare when contrasted with the calcareous districts in this deposit, where they found more congenial beds, and the rock is now literally filled with their remains. The deposit here is from 8 to 9 feet in thickness. From Hope-

well to the mouth of Licking, a distance of 10 or 11 miles, the dip of the strata south easterly is very small, not more than 10 feet to the mile. Near the top of Putnam hill, at the mouth of Licking, we find a grey, shelly lime-rock in a state of decay, containing the same fossil shells which accompany the calcareo-silicious rock in all the localities I have visited. Between this locality and Hopewell, no indication of this rock is seen *in place*, but fragments are found in the ploughed fields, and occasionally a piece on "Putnum hill;" from which circumstance we are led to conclude that this deposit has been decomposed and changed to soil, from the fact of its containing so large a proportion of lime in its composition.

Proceeding southerly along the waters of Moxahala creek, and parallel with the Muskingum river, we find it lying high in the hills, and especially in Brush creek township, near the south west corner of Muskingum county. Here it assumes a yellowish color and softer texture, resembling a fine grained, buff colored lime-stone. It contains the usual fossils, amongst which terebratulæ are the most abundant. A short distance south, near the north line of York township, in Morgan county, it is seen in place, lying in regular successive strata, and forming a bed of 8 or 9 feet in thickness. From this place, which is about 2 miles north of Deavertown, it can be traced down the waters of Island run, and Oil run, to the Muskingum river, and to a point two miles above M'Connelsville, where it lies on a level with the surface of the water during its low stages. At M'Connelsville, this rock is passed in boring for salt water at the depth of 110 feet below the bed of the river, and is found to be a valuable and certain guide to all the borings below this point. The lower or main salt rock is reached at the depth of about 650 feet below the calcareo-silicious rock, with little variation for the distance of 10 or 12 miles below, or as far as any wells have been sunk; which is a proof that the intermediate strata vary but little in their aggregate, if they do in their individual thickness. The dip of the strata in this vicinity is much greater than I have noticed at any other place. At Campbell's mills, two miles from the Muskingum river, on Island run, this rock forms the bed of the stream, in a smooth regular floor, over which the water falls 15 feet, having cut away the dark bituminous shale which lies under the rock five or six feet in depth. The deposit here is a true calcareo-silicious rock, considerable portions of which are nearly pure lime. It breaks into irregular conchoidal fragments with a dull lustre, and contains the usual fossil shells. In the bed of "Oil run," two miles south of Campbell's, so named from a spring of petroleum, found about a mile from its mouth, this rock has a very rough, irregular surface, probably occasioned by the wasting and dissolving of the calcareous portions of the deposit, while the harder quartz remains unaffected. From Deavertown to Campbell's, a distance of about 8 miles, there is a dip of 250 feet, and to the river, about 50 feet more. The hills are so high as to contain the 5th, or non-fossiliferous lime rock, of Wolf creek, at 50 feet below their summits. The 4th fossiliferous lime-rock lies at about 100 feet below it, and at least 100 feet above the calcareo-silicious rock at Campbell's mills. In this portion of the coal measures, there is a great increase in the thickness of the strata, superimposed on this rock. At M'Connelsville, it is not less than 400 feet from this deposit to the tops of the hills, half a mile west of the river. At Dr. Martin's, 5 miles above, the 5th, or non-fossiliferous lime-stone, with the accompanying marls, is increased to nearly 100 feet in thickness. Four miles west of M'Connelsville, the calcareo-silicious

rock is seen in the beds of the head branches of Wolf creek, and may be traced south westerly from the bed of one stream to another, at intervals along its eastern side, from this place to Gallia county. Along this line, however, it has more the appearance of an imperfect lime-stone than that of a silicious rock.

Value and importance of the Buhr-stone.

The importance of this article in a commercial and domestic point of view, may in some measure be estimated, when it is stated, by intelligent persons who have been long engaged in the manufacture of mill-stones, that the annual amount of the manufactured article is not less than 20,000 dollars; and that it may be safely calculated at this sum, for twenty years past. When to this, is added, the money saved to mill owners, from the use of the native, instead of the foreign buhr-stone, that amount will be nearly doubled. It came into use about the year 1807; and the first pair of stones constructed of this article, on the waters of Raccoon, was by Abraham Neisby, a native of Germany. He being familiar with the foreign, or French buhr, and seeing this rock so nearly resemble that in composition and aspect, was led to make trial of it. Henry Castle, also began to make them about the same time. Soon after this, our embarrassments with Great Britain, and other commercial difficulties, led the American people to establish manufactories of various articles, heretofore altogether brought from Europe. Amongst other things, the enhanced value of the French buhr, led to the search of a material of a similar quality at home, and no doubt brought the domestic article much sooner into general use in the Western States, and especially in Ohio. The early manufactured mill-stones were made of a single piece; but these often proving to be of unequal density, and not making good flour, were abandoned, and staves constructed of separate blocks, cemented with plaster, and confined together with iron bands. Where these blocks are selected with care, by an experienced workman, the flour is said to be equal in quality to that made by the French stones.

From the year 1814 to 1820, the price of a pair of 4½ feet stones was $350, and a pair of 7 feet, sold for $500; while the foreign article sold for a still higher sum. The 4 feet stones now sell for $150. In the townships of Richland, Elk and Clinton, a large number of the inhabitants are engaged in the dressing of blocks, and in the construction of mill-stones. The buhr-rock is a mine of wealth to the inhabitants, and has contributed largely to the prosperity and independence of this whole region of country. The manufacture of mill-stones is not confined to the waters of Raccoon, but is also carried on to considerable extent in Hopewell township, Muskingum county. The quantity is apparently inexhaustible, and new quarries will be opened, at points where it is not at present looked for, and probably of a more even and compact texture than that now obtained. Few or no quarries have been yet worked by drifting under the sides of the hills, but the rock is generally procured by what is technically called "stripping," or excavating the superincumbent earth, near the top of some ridge or hill, where it is easy of access.

Quality and character of the Buhr-stone.

The characteristic excellence of the best mill-stone rock consists in its uniform texture; composed of pure quartz; free from lime and oxyde of iron, which more or less pervade the larger portion of the deposit; color

light grey; structure open and full of cells; the fragments giving a clear metalic sound, when struck with the hammer. How far this agrees in character with the French buhr, will be presently shown. Although an intensely hard rock, yet its structure is similar to that of all other stratified rocks; and it has a regular horizontal division, as well as cross fracture. The bed, or horizontal surface, is the one which contains the most cells, and is selected for the face of the mill-stone. In nearly all the quarries, the rock is found naturally broken into rectangular masses of various dimensions. As the larger portion of the quarries contains more or less of petrified shells, those the most free of foreign matters, are considered the best. While the fossils in the French rocks are all of fresh water species, those in the Raccoon buhrs are altogether of marine origin; and as this deposit is a member of the coal series, it is a much older rock than the French, which belongs to the tertiary group.

In the composition and chemical affinities of the Raccoon deposits, there is a close resemblance to those of the Paris basin, as they both abound in calcareous materials, as well as silicious. In several of the Raccoon beds, there is a stratum of lime-stone, two or more feet in thickness, both above and below the buhr-stone. In such quarries, the portion suitable for mill-stones is only from two to four feet in thickness. In others, the quartzy portion is below, and the silicious lime-stone above. The greatest thickness of the deposit in any one bed, is nine feet. In how many points of character the Paris and the Raccoon beds agree, may be seen in the following extracts from "Cuvier's Essay on the Theory of the Earth."

"*Millstone without shells.*"

"This formation consists of iron shot clayey sand, greenish, reddish and whitish clay marl, and *millstone;* and although separated by Cuvier from the *flint and silicious limestone formation,* appears to be a member of that series. This millstone is a quartz, containing a multitude of irregular cavities, which are traversed by silicious fibres, disposed somewhat like the reticular texture in bones. These cavities are sometimes lined or filled with red ochre, clay marl, or clayey sand; and they have no communication with each other. Most of the millstone found around Paris has a red or yellowish tint; but the rarer and most esteemed varieties have a blueish shade of color. The blueish variety is the most highly prized, because it affords a whitish flour; and a millstone of this kind, six feet and a half in diameter, sells for 1200 francs. We never observe in its cavities any silicious stalactites, or crystalline quartz, and this character enables us to distinguish in hand specimens, this millstone from that in the silicious limestone: it is sometimes compact, or without cells. Another prognostic character of the millstone, is the absence of all fossil, animal, or vegetable productions, whether of fresh or salt water," "The most extensive mass of this millstone occurs in the plateau, which extends from La Ferte on the Marne, 16 leagues from Paris, nearly to Mont Miral; and here it has been quarried upwards of 400 years, for the excellent millstone it affords. The lower part of the platteau is marine limestone; the upper part, on the edges and towards the Marne, of marl and gypsum; but in the middle of an iron shot and clayey sand, which forms a bed upwards of sixty feet thick. The millstone occurs in this great bed of sand, and varies in thickness from three to five fathoms; but millstones cannot be made of every portion of the mass—a bed of rolled masses of millstone, about a foot and a half thick, lies over it—over this a thin bed

of iron shot sand, containing smaller pieces of millstone, and above this bed is one of sand from twelve to seventeen yards thick. If the stone rings when struck with a hammer, it will answer for large millstones. The bed never affords more than three millstones in the direction of its thickness. It frequently happens that the fissures allow the workmen to extract the masses in a perpendicular direction; and these are the best. These pieces are exported from France to England and America.

"Quartz rock with shells."

"The second fresh water formation in the vicinity of Paris, consists of two sorts of stone—flint and silicious limestone. These substances sometimes occur independent of each other; in other instances, they are intimately mixed together." "All the varieties, both hard and soft, are traversed by empty vermicular cavities, whose walls are sometimes of a pale green color." "The essential character of this formation is, that it contains fresh water and land shells, nearly all of which belong to genera that now live in our morasses, *but no marine shells*—at least in such places as are distant from the subjacent marine formation."

From the above extracts it would seem that the Raccoon and Paris buhr stone, agree in mineral composition and mineral characters, but differ in the age of the deposits. Of course, they cannot be said to be geologically similar rocks; although the same chemical action may have attended their deposition, and origin.

Mineral contents.

No mineral substances have yet been found associated with the quartz of this deposit, except sulphate of barytes, crystallized carbonate of lime and crystals of quartz. The first is rare, the second not abundant, but the latter is found in brilliant druses, with regular faces, in some portions of the deposit, especially in Hopewell, Muskingum county. Some of these are very beautiful, and afford fine specimens for the cabinet, being occasionally tinged red or brown by some metallic oxyde. The striking similarity between these crystals and those about the lead mines of Missouri, has led to some expensive but fruitless searches for lead and copper ores; the excavations made by the aborigines having served to strengthen this belief. I have seen no other metallic minerals but those of iron, which probably percolates from the bed of ore which rests on the calcareo-silicious deposit, On the heads of Monday Creek in the N. E. corner of Green township the quartz and lime have been precipitated from the liquid which held them in solu ion, in a fine white powder, and afterwards loosely cemented. Selected portions of this rock make valuable hone-stones, and have been extensively wrought for this purpose.

1.—General character and agricultural capacity of the calcareo-silicious region.

As a general remark, the country is hilly, but the deposit of this rock is of so little thickness, and its inclination so gradual, that it can have but a trifling influence in modifying the face of the region over which it is spread; where it crops out on the tops of the hills and lies in broad continuous shells of quartz, it has doubtless had some effect in preserving the deposits beneath it from wasting away, and thus kept the surface of the hills, or ridges over which it lies, at their original elevation. This is

apparently the fact on "Flint Ridge," which is the most elevated tract in that region of country.. Between the head waters of Salt creek and Raccoon creek, in Richland township, the same protection seems to have been given, and the ground is covered with horn-stone. But in those portions of the deposit where lime prevailed, this rock has decomposed; and wasting away, has mingled with those above and below it, forming a rich loamy soil. In an agricultural point of view, the country traversed by this deposit is equal in fertility to any of the hilly portions of the coal measures. The forest trees are of the largest size, especially the yellow poplar and chesnut; and the soil productive of all the crops common to this climate. Average thickness, 9 feet.

2.—Iron ore—silicious quality.

Resting on the calcareo-silicious rock, lies a thin bed of brown silicious oxyde of iron—texture porous, and filled with cavities, many of which are lined with mammillary masses of iron ore. As this deposit rests immediately on the silicious rock, it imparts to it the ferruginous matter so injurious to the color and quality of the stone. This, so far as I have observed, appears to be a regular and constant attendant on the Raccoon buhr stone, and is found scattered over the tops and hill sides of this region, where the rock has been wasted away; its silicious and ferruginous qualities, protecting it from decay. Its structure and external character are so peculiar that when once seen, it can hardly fail to be again recognized, and will serve as a guide in tracing the former course of the buhr stone, in spaces where it is now wasted away. Thickness, 6 to 8 inches.

3.—Sand rock.

Above the iron ore is found a thick bed of sandstone; it is rather coarse grained, chiefly silicious, but little mica, of a brown color and loose texture, easily crumbling into sand on exposure to the elements, and is the grand source from which is furnished the immense masses of sand which fill the beds of the Raccoon and its tributary branches. A fine view of its superposition on the Buhrstone may be had at a locality on section 26 in Elk township, called the "wild cat's den." It here crowns the top of the hill, affording an extensive view of the alluvions of the creek. On the Muskingum river this rock assumes a more slaty argillaceous character; but in Hocking and Perry counties it maintains its sandy texture. Its thickness may be estimated at 20 feet.

4.—Shale and slaty clay.

Over the sand rock is a deposit of slaty clay, of a light ash color—when exposed to the weather, or lying near the surface of the earth on hill tops, it changes into a bed of light colored clay. This is the fact at Hopewell, on Flint ridge, where it affords a material suitable for pottery, or the large crucibles used in glass furnaces. A similar clay is found a few miles west of Zanesville, near the hill tops, and applied to this use by the manufacturers of glass in that place. At Dr. Martin's, on the Muskingum river, we have a fair view of this deposit; but the shale is darker colored. At this locality, it may be estimated at fifteen feet. Only the lower portion of the deposit is composed of the fine fire clay, the upper and middle parts, being more sandy and micaeious, are fifteen feet.

5.—*Coal.*

Resting on the micaceous and slaty shale lies a deposit of slaty bituminous coal. The quality is rather poor: it burns with a ready flame when first ignited, but soon melts and runs together, obstructing the grates and the circulation of the air. The color is lighter, and specific gravity less, than common coal. A similar coal is found in the tops of the highest hills about Zanesville, nearly three feet in thickness. At Dr. Martin's, five miles above M'Connelsville, it is about twenty inches in thickness. At this place we have a good view of all the strata between the calcareo-silicious rock, and the fourth fossiliferous limestone; and the thickness of each is estimated from this locality, with reference, however, to such other as have come under my notice. The thickness of all the beds vary at different places, especially if they are distant from each other. The coal of this bed may be estimated at two feet.

6.—*Shale and argillaceous slaty sandstone.*

Over the coal is a bed of bituminous and slaty shale, containing nodular masses of argillaceous iron ore, of about ten feet in thickness; on this rests a bed of slaty sandstone, in layers of only a few inches in thickness. This stone is remarkable for its smooth beautiful bed faces, and regular thickness; it can be quarried into large flags for paving side walks, or laying the floors of cellars or kitchen hearths. This portion of the deposit is about fifteen feet in thickness.

7.—*Coal.*

Resting on the sandstone is a thin bed of clay, on which lies a deposit of coal. The quality is tolerably good. The same bed is seen in the river hills above here; below, it soon sinks under the bed of the Muskingum. Thickness, 2 feet.

8.—*Shale and slate clay.*

Over the coal lies a deposit of bituminous shale and slate clay. In this member of the series, no iron ore was observed. Thickness, ten feet.

9.—*Compact sand rock.*

Over the shale lies a thick deposit of compact sand stone. The texture is rather coarse and silicious where it has tumbled out of the hill side, by the undermining action of the water of a small branch which puts into the Muskingum, not far from the outlet of Island run, it lies in large masses. At this spot I did not observe any stems or coats of fossil coal plants; but in Gallia, a little east of the village of Vinton, a rock, whose geological position and structure is similar, contains fine casts of "calamites cannoformis and other coal plants." Thickness, 25 feet.

10.—*Slaty shale.*

Over the sand rock we find a thick deposit of shale and slate clay, on which is a thin bed of coal, of only a few inches; at this locality the coal has given a dark tinge to the lower layer of lime-stone, which rests upon it. The same effect is seen on the lime rock, in the hill near the town of Vinton, in Gallia county. This heavy bed of shale, with the sand rock

above, and lime below where it crops out on the surface, and they become mingled together, forms a rich and durable soil. Thickness, about 30 feet.

11.—*Lime rock.*

Resting on the shale, which in some places approaches a blue argillaceous sand stone, we find the upper fossiliferous limestone. At this locality, in Bloom township, it lies at an elevation of 100 feet above the base of the hills, while at M'Connelsville, five miles below, it is found in the bed of the river, and has been recently penetrated in excavating the lock-pit at that place. From Bloom township, it can be traced on to the hills north and west of here, especially in the dividing ridges of Sunday and Moxahala creeks. It lies in regular beds or layers, of eight or ten inches to more than a foot in thickness. In some places, especially on Sharp's fork of Federal creek, in range 12, township 8, section 31, these layers are separated by deposits of calcareous shale, increasing the thickness of the deposit to 12 or 15 feet. In other localities the shale is wasting, or has been wasted away by the action of water; and the lime rock is reduced to 6 or 8 feet in thickness. It is every where filled with fossil shells, in some instances so abundant as to form the greater portion of the rock, cemented together by argillaceous matter. For this reason, this deposit may be known and recognized at remote and distant points of the coal measures, which it is much more difficult to do with the non-fossiliferous shales and sandstones. This character makes such beds valuable to the geologist, in locating other deposits, either superimposed or subordinate to these strongly marked beds. Amongst the fossils of this deposit we see joints of encrini and terebratulæ, generally very small; producti, gryphea, and few or no spiriferi. In place of which we find many equivalved bivalves, and several new genera of turbinated univalves, not found in the lower or older limestones. In some localities, especially near the outer margin of this rock, the lower layer of the deposit is made up of fragments of limestone, forming a calcareous conglomerate. It may be seen on a hill three miles south of Athens; also, in Morgan township, in Gallia; and I have seen the same peculiar rock on Wills' creek, in the southwest corner of Guernsey county. It seems to have been broken up by the action of water, as a recently formed rock might be by the waves on a beach, and has apparently been brought about by a similar cause to that which acted on the silicious conglomerate, in Richland township, and afterwards covered by a fresh deposit made in quiet water. These fragments are in some places not larger than a pea, in others coarser; but all have been rounded by attrition—were it sufficiently hard to receive and retain a polish, some portions would make a handsome brecciated marble; but this quality it lacks from the formation being sedimentary and earthy. Soon after the era of this deposit, a change seems to have taken place in this part of the ocean, either from the raising up of the bottom, or from the draining off of the waters, rendering it too shallow for the existence of the testaceous animals which then peopled it. In the series of rocks above this, amounting to more than 400 feet, I have as yet been unable to find any other than fresh water shells or the stems and impressions of the foliage of coal plants, which probably grew either near estuaries, or amidst fresh water lakes. Further examinations will, however, most probably bring to light, additional evidence of the longer continuance of the oceanic waters over this portion of the valley.

Range and extent.

The upper fossiliferous lime-rock is at this place, (Sharp's fork of Federal creek,) fifteen feet in thickness, and lies about 80 or 100 feet below a bed of coal, which I have many reasons for believing to be the same deposit as the Pomeroy bed, on the Ohio river, in Meigs county. The position of the limestone is conformable to that of the superincumbent beds, and as we travel westerly, rises gradually on to the tops of the ridges of Sunday creek hills. The same rock is seen on the hill in the town of Athens, and at various other places, west and south of that locality.

From Athens county, this deposit may be traced across the west end of Meigs county, into Gallia. Here, in the township of Morgan, it is seen in the heads of Campaign creek, lying in a thick bed, filled with the usual fossils. The inferior layer, from its resting on coal, is nearly black. From the heads of Campaign, it is traced into Springfield, and down Chickamoga creek, to within a few miles of Gallipolis, when it sinks below the bed of the creek. At the mouth of Lime-stone run, eight miles north of this, it lies at the base of the hills. Several kilns of this lime-stone have been burnt here, and on Chickamoga. On Leading creek, still further north, in Meigs county, it sinks below the bed of the stream, near the upper salt well. As the dip of the strata is east south-east, and the river Ohio here, for many miles, pursues nearly a north and south course, the seeming difficulty of its disappearance near the Ohio for so long a distance, is explained, as the direction of the Ohio is in the line of bearing and across the line of dip.

The upper fossiliferous lime-rock, can be traced across the counties of Morgan, Athens, Meigs, and a part of Gallia, with an average width of 10 or 15 miles from its western outcrop, to its disappearance below the beds of the streams east. The average thickness of this deposit may be estimated at 8 feet.

No. 12.—*Slate Clay, Shales, and thin slaty Sand-rock.*

In situations where the original strata have been but little disturbed, we find a bed of pale blue slate clay, resting on the lime-stone, which, when exposed to the weather, falls into a blue plastic clay. Above this is a shale, containing nodular masses of argillaceous iron ore, ending in slaty sand-stone. A fine view of this portion of the series may be obtained on Sharp's and Cutler's forks of Federal creek, in the township of Ames, Athens county. Considerable quantities of iron ore are imbedded in this shale, which makes its appearance at several places in Meigs and Gallia counties. It is also well developed in the hills near Dr. Martin's, in Morgan county. At some localities, the ore is apparently so abundant as to be valuable for manufacturing purposes, especially on Federal creek. The whole series of slates and shales are at least eighty feet in thickness.

13.—*Lime-stone, hard and compact—containing a portion of Iron Ore, and Sulphuret, sufficient to coat over the surface with a buff colored crust when exposed to the weather.*

This bed is more fully developed in Marion township, Athens county, on section 24, town 7, and range 12, than at any other spot which I examined. This locality is near Mr. Patterson's, on one of the head branches of Federal creek. It is a regular attendant of the Pomeroy coal bed, which lies over it. In some places it is very thin, and lies in amorphous

or nodular masses, disseminated in the compact, carbonaceous slate clay which lies under the coal. No fossil shells were noticed. In Marion, this rock is 4 feet in thickness; in other places not more than a foot; average 2 feet.

14.—*Slate Clay—compact and carbonaceous—dark colored.*

It is of a quality suitable for the manufacture of fire bricks, and receives its dark tinge from the coal which rests upon it. The thickness varies at different places, but averages about 3 feet.

15.—*Coal—black and bituminous.*

For distinction, and as a mark of respect to the enterprising individual who first promoted the opening and extensive working of this valuable bed, at the village of Pomeroy, on the Ohio river, in Meigs county, this deposit may be denominated "the Pomeroy coal bed."

Range and extent.

It may be traced from the south side of Morgan county, across Athens and Meigs, to the Ohio river. North of the head of Federal creek, the coal becomes thin, but can probably be followed and recognized to the vicinity of M'Connelsville. It is the most fully developed on the waters of Federal creek, the westerly branches of Shade river, on Leading creek; and on the Ohio river; pursuing in the line of its bearing, or "strike," rather a north easterly and south westerly course, with a pretty regular dip to the east and south east, except in the high lands a little south of the town of Athens, where the sand-rocks are greatly increased in thickness, and the regularity of the dip broken in upon, either from faults, or some upheaving force from below. From present appearances, this high ground has diverted the course of the Hockhocking river, and turned it easterly from its direct route to the Ohio. The head branches of Shade river take their rise in this elevated ridge, and flow south easterly to join the Ohio about 12 miles below the mouth of the Hockhocking, in a very broken and hilly region. If we look on the map of this State, it will be seen that all the streams which rise within, or across the western side of the coal measures take a south easterly direction, which, it may be suggested, is probably caused by the east and south easterly dip of the rock strata. The Ohio river, after receiving the accumulated waters of the whole basin, flows south westerly in the most depressed portion of the coal measures, cutting its channel across the strata, where it found the least resistance.

From the extensive boundary of "the Pomeroy coal bed," on both banks of the Ohio river, giving it commanding and peculiar facilities for market, it may be deemed one of the most important beds on the west side of the coal deposits. For these reasons, it will demand a more particular history of its extent and appearance at different localities.

Commencing, then, in Addison township, a little below the mouth of Kuyger creek, in Gallia county, we find a bed of coal near the top of the river hill, at an elevation of 150 feet above the bed of the Ohio. This spot is about 14 miles below the point where the Pomeroy coal dips under the surface of the river, in Salisbury township, Meigs county, and is also about seven longitudinal miles west. The coal here is about eighteen inches thick, with a roof of bituminous shale of three feet, and a coarse

sand-rock above. Five miles above Kuyger, the same coal bed is seen in the hills at the height of 70 feet above the bottoms, and has increased to four feet in thickness. At this locality, several masses of the lime-stone, which lies under the coal, are seen scattered on the slope of the hill below. At the mouth of Leading creek, two or three miles higher up the river, the thickness has increased to nearly 5 feet, and the elevation lessened to about 40 feet above the bottoms. Three or four miles above this, at the village of Pomeroy, the river makes a bend to the south east, and the coal in its eastern dip, gradually approaches the water and sinks below the surface in range 13, town 2, and section 36, at a point a little north of due east from the mouth of Leading creek, and distant, on a westerly line, only about 5 miles, but as much as eighty by the course of the river, where it disappears, and for several miles below, the coal is fully 5 feet in thickness. Following the same bed over on to Leading creek, 7 miles from its mouth, in a north westerly direction from Pomeroy, we there find the coal at an elevation of 150 feet above the bed of the creek, and increased in thickness to fully 6 feet; showing the regular rise of the rock strata, in a west and south west direction, and a dip to the east. The sand rock here rests on the coal, without any intermediate shale, which may account for its greater thickness than at the village of Pomeroy, where there is a deposit of several feet of shale over the coal. In a west and north west direction, the coal may be traced on to the heads of Leading and Kuyger creeks, and runs out in Gallia and south west part of Athens county, becoming gradually thinner, until it mingled with the soil on the surface. Returning to the mouth of Carr's run, and pursuing the course of the Pomeroy coal bed northerly, we find it in the bed of this run about a mile north of the village; and as we ascend on to the hills, we rise above the coal, which disappears under the ridge that divides the waters of Carr's run from those of Thomas's fork of Leading creek. On descending this ridge, the coal appears a little above the bed of the stream, on section 16, more than 3 miles from the river. It is here 5 feet in thickness, lying under the same coarse sand-rock, with a bed of shale above the coal. Still traveling northerly, we rise on to the dividing ridges between the waters of Leading creek and Shade river; on descending which, two miles farther north, in range 13, town 3, and section 9, on the land of Mr. Barton, it is seen in the bed of the west branch of Shade. The coal here is 4 feet thick, resting on blue clay, with a thin bed of compact slate clay over the coal; lying on which is a deposite of bituminous shale, six feet in thickness, and of so rich a quality as to burn freely. Above this, the coarse sand-rock is seen in a bed of 50 or more feet in thickness. In the clay over the coal, are a few scattered masses of nodular lime-stone, highly charged with sulphuret of iron. The coal is here of a good quality, and breaks into acute angled fragments, similar to that in the Pomeroy beds on the river. Near the north line of the county of Meigs, on the farm of Mr. Storer, the coal is seen lying in the bed of a branch, and about ten feet above it, there is a thin vein of coal, with slate and shale interposed between them, and similar masses of nodular lime-stone, to those seen at Barton's bed. Above them lies the accompanying bed of coarse, loose sand-stone in heavy masses. In traveling northerly, into Athens county, we leave the bed of the main stream of Shade, and pass over elevated ground for more than a mile, and descend on to Pratt's fork, a westerly tributary, in Lodi township. A mile or more west of the road, the coal is found increased in thickness, and gradually rising on to a higher level. From this point, it was traced across

Lodi township, into Canaan, to within 5 or 6 miles of the town of Athens. Here the coarse sand-rock is greatly increased in thickness, and the country rises into lofty ridges. This locality is on the west side of town 5, range 13, and also on the westerly side of ' the Pomeroy coal bed," the general range of bearing of which is north easterly, or east of north. The beds on the Ohio, are in the same range of townships, and distant in a direct line, about 18 miles. A little above the mouth of Federal creek, which is about ten miles from this place, and on a line somewhat north of a due east course, the coal is said to be 5 feet thick, and sinks below the bed of the stream. The dip is in that direction, and at 20 feet per mile, would give the coal at this locality an elevation of 200 feet above the bed of the Hockhocking, at the mouth of that creek. It is here reduced in thickness to between 3 and 4 feet. In the town of Athens, 4 or 5 miles north west, we find the upper bed of fossiliferous lime-rock, lying on the top of a hill in the town of Athens, at an elevation of probably 180 feet above the bed of the Hockhocking. Two miles south east of Athens, across the river, the country rises into a lofty ridge, at least 300 feet above that stream. This very high ground has apparently turned the course of the river and caused it to flow nearly due east to the mouth of Federal creek; below which its course is more southerly to the Ohio. From the point where the coal is last seen above the mouth of Federal, it can be traced all the way up the creek into Marion township, in range 12, and gradually rising from the bed of the creek, because the direction pursued is north easterly. From the forks of this creek upward, I have examined it at several points, and find the upper fossiliferous lime-rock lying about 80 or 100 feet below the coal, especially on section 24, in town 7, range 12. Here we find the coal and shales arranged in the following order: Coal, 4 feet, resting on the compact slate clay; over it, a bed of ash colored, compact shale, 1 foot; bituminous shale, 18 inches, so rich as to burn; thin coal, 18 inches, on which rests a coarse grained sand-rock, very thick, and bearing a close resemblance to the order observed at Barton's, in Meigs county. East of this place, the coal dips below the beds of the streams, and is covered by the deposits which are to be subsequently named. On a line, this locality is north and a little east, more than 30 miles from the village of Pomeroy. The average width of "the Pomeroy coal bed," from its outcrop on the hills westerly, to its disappearance under the beds of the streams easterly, may be estimated at 10 or 12 miles. Its average thickness, 5 feet.

Fossils which accompany "the Pomeroy Coal bed."

In the shale beds, which generally form the roof of this coal, we find innumerable casts and impressions of the foliage and stems of various coal plants, of which have been collected more than twenty species.— Amongst them may be recognized of the *Equisetaceæ*, the *Calamites* and *Equisetum*—of *Filices*, the *Sphenopteris*, *Glossopteris Neuropteris*, *Pecopteris*, &c. The Lycopodiaceæ, such as Lepidodendron, Sigillaria, &c. are rare in this deposit, but are common in the earlier formed beds.—The most interesting feature of the rocks connected with this coal, is the great abundance of fossilized stems and branches of trees, that are found to accompany the coarse sand-rocks which lie over the coal, in several localities which have been visited. So few quarries, or excavations, have been yet opened in this rock, that we can only discover them in beds of streams, or situations where the rock has crumbled away by natural causes.

Fragments of fossilized trees are seen in several of the branches of Federal creek; the beds of Campaign and Leading creek, but more abundantly in the heads of Shade river, township of Lodi, Athens county. The extreme northerly branch of this river, rises in that high ridge of land south of Athens, before noticed, and not more than a mile from the Hockhocking river. About 3 miles south, this branch becomes a rivulet of ten or twelve feet in width. In the bed of this rivulet, and also in one which heads with it, and puts into the Hockhocking, are found numerous tabular, oval masses of silicious composition. They are from 4 to 10 inches in thickness, and from 2 to 3 feet in diameter, with others that are smaller. One of the sides is almost invariably concave, or depressed in the center, and the opposite one plane or slightly convex. They are evidently petrifactions of some vegetable substance, as the traces of the fibrous structure is very apparent in all the specimens. The form of these masses very much resembles that of the base of the *Stigmaria ficoides*, with the branches all broken off. They are composed of the hardest silicious matter, of a redish, grey color. Fragments were broken and brought away, and arrangements made for procuring a perfect specimen. Isolated masses are scattered along the bed of the branch for more than a mile, the bottom of which is composed of a slaty sand-rock, deposited in thin layers, highly inclined, and of slight coherence. No specimens were found in place, but they were doubtless originally imbedded in a coarse sand-rock, which lies over the coal. This opinion is strengthened by the fact that portions of the trunks and roots of the fossil trees found lower down the branch, are often ploughed up in the fields, on the hill sides, 50 or 80 feet above the bed. A few miles lower down, and six and a half miles from Athens, the beds of several small streams, all tributaries of Shade, and rising over a space of 8 or 10 square miles of surface, are found strewed with the segments of trunks of fossil trees, varying in diameter from a few inches to 18 or 20 inches. The larger sections are generally perforated by a circular opening near the center, from 1 to 4 or 5 inches in diameter. The regular shape of the pieces, resembling transverse sections of a log of wood, seems to be the result of a peculiar mineral organization, disposing the fragments to assume a cubic form, had the exterior of the fossil been square instead of circular. The ligneous structure of the original tree was coarse, very distinct, and highly vascular; it is now replaced by silex, in many specimens beautifully agatized.— Some of the pieces are filled with perforations, the size of a quill, and larger, which seem to have been made by a worm. This, most probably, was done by an ancient *Teredo*, after the trees were torn up, and floated down some river to the ocean. Fragments, three or four feet in length, are the longest yet discovered. The quantity of specimens is so great, that we might be led to suppose a whole forest had originally been entombed in this place, covered with beds of a highly silicious quality, and consolidated into sand-rock. These rocks being less dense and compact than the fossilized wood, have, in the course of ages, crumbled into soil, and left the imbedded trees to fall out in fragments, and gradually wash down the slopes of the hills into the beds of the streams, where they are now found. As the age of this rock is long anterior to the Tertiary, these fossil remains are not likely to be allied to any living species of tree which now vegetates in the forests of Ohio. It most probably belongs to the tribe of Gymnosperma, of Lindley; a race of plants whose seeds are naked or formed without a pericarpium, or envelope. From the great vascularity of the trunk, and the fact of the fragments being almost entirely com-

posed of the shafts of the trees, with few or no branches, we are led to conclude, they may be attached to the order Cycadea, the woody fibre of which is very similar in structure to the coniferae, or pine race, and which are only found in some of the more recent coal deposits. In the final report, we hope to give drawings of these interesting fossils, and satisfactory descriptions of the family to which they belong.

16.—*Iron Ore.*

Imbeded in the shale, which lies over the Pomeroy coal bed, at several localities, we find a deposit of fragmentary, argillaceous iron ore. It resembles bog ore, considerably, but is more compact and heavy than that variety of ore. It is generally coated over with yellow oxyde, and appears to be composed of cemented fragments. It is considerably abundant at the locality in Marian township, and also on Sharps fork, in Bern and Homer townships, Athens county. The thickest and most valuable bed of this variety of ore, and which, from it position, appears to be a continuation of the same deposit, lies near the top of the ridges, between the head branches of Kuyger and Champaign creeks, in the township of Cheshire, Gallia county, on sections No. 19, 20 and 25. It has as yet been but partially opened, and is about two feet in thickness. The ore is an argillaceous oxyde, breaking easily into cubic fragments, coated with yellow ochre. Should further search prove the ore to be extensively spread over this region, and to be of good quality, its proximity to the Ohio river, not more than four miles, will add much to its value; a deposite of coarse sand-rock lies over the ore, which in many places has wasted away, leaving the bed covered only with earth, ——; ore, 2 feet.

17.—*Sand Rock—coarse grained, friable Sand Stone.*

This rock rests upon the shale over the coal, and, in some localities, immediately on the coal itself; where this is the case, the sulphurets, which accompany the coal, seem to have penetrated the rock for some feet, covering the outer layers of sand with minute crystals of sulphate of iron, or alumine; and in shaded, damp situations, rendering the rock tender, and disposed to exfoliate in thin sheets from the vertical face of the cliff. This is strikingly the fact on section 24, township 7, and range 12. In other situations, the rock is firmer and compact. Wherever this rock has been noticed, it lies in thick heavy masses, especially on the heads of Shade river, in Lodi, where it attains the thickness of 80 or 100 feet; at other places, it is usually from 40 to 50 feet, especially between Lodi and the Ohio river. The upper part of this deposit might be divided into one or two more sections, especially a coarse-grained siliceous sand, without any mica, a layer of which, at the village of Pomeroy, has been worked into excellent drip, or filtering stones. At Dr. Martin's, on the Muskingum river, we find a similar rock, lying over a thin bed of coal of 18 inches, or 2 feet, whose position in the series corresponds to this, and is probably the same; the upper portions of which, above the coarse sand, are in thin layers, containing considerable mica. It is a difficult task to trace a single deposit of shale or sand-stone for many miles—the outcropping edges of the strata crumbling down into soil, and often interrupted by ridges and hills, which contain other superimposed rocks: where peculiar fossils are imbedded in them, the recognition is easy; but, in general, a stratum can be only determined by its *connection* with others,

and its *position* between certain strongly marked deposits. Beds of much volume seldom change their *character* within moderate distances, but oftentimes their *thickness*. This member of the series contains the fossil trees described above, and may be estimated at 50 feet.

Agricultural character of the region traversed by the Pomeroy Coal Series.

The central and western portions of Meigs County, and the southern of Athens, are watered by Shade river and Leading creek. The country is generally hilly and broken nearer the larger water courses, but affords extensive tracts of fine rich farming lands, especially in the heads of the streams. The whole was originally covered with a heavy growth of forest trees. The surface of the earth being composed of the outcropping edges of the shales, sandstone and lime, crumbled down and mingled with the decaying vegetable matter of the forests, affords a soil that is rich, productive, and durable. The perous sand-rocks, absorb and retain the rain-water, so as to furnish lasting springs and streams, sufficient for the wants of the inhabitants during the dryest seasons. Those distressing, and often ruinous droughts, so common to calcareous formations, are here unknown. On the middle branches of Federal creek, and the high lands between those branches and Sunday creek, the surface is broken, by the wasting action of water, into long, elevated hills, crowned with narrow ridges, which, in some places, for miles in extent, are barely wide enough for a road. These narrow spines are generally conformable to the course of the streams, and rise to the height of 50 feet. At the base of these ridges is a flat, or terrace, of a number of rods in width, which gradually slopes down to the creeks, affording fine farming lands. The singular form of these ridges is attributable to the lime-rock, of which they are composed, and which here overlies the sand rocks and shales of the Pomeroy coal formation. Its more compact texture has preserved it, while the softer shales and sand stones have given way to the water and atmospheric influences. The non-fossiliferous, or upper lime-rock, here lies on the tops of the narrow ridges, and often forms a natural pavement for considerable distances. In other spots it is broken into fragments, intermingled with which are seen nodules of the red oxyde of iron, of a color nearly as brilliant as vermillion. Although the country on these streams is hilly and broken, yet the "Federal Creek Hills" are noted for their fertility, and clothed with sugar-trees and beach to their tops. The whole region is productive in grain and grass. On Leading creek, some of the townships are distinguished for their fine meadows; and no part of Ohio affords more desirable and healthy ranges, for flocks of sheep and herds of cattle, than those portions traversed by the Pomeroy coal beds.

18.—*Reddish Calcareous Shale.*

Resting on the upper portion of the slatey sand-rock, noted in section 17, is a thick bed of reddish brown calcareo-argillaceous shale, intermixed with layers of loose yellowish lime-stone, which easily crumbles on exposure to the weather. This portion of the series was taken in the Muskingum river hills, in Bloom township, Morgan county, and near Dr. Martin's. A channel has been cut through the whole deposit in search of coal. Its thickness is about 50 feet.

19.—*Blueish Clay Shale.*

Lying on the lime and redish shales, we find a deposit of clayey shale, blue or dove-colored. It is free of mica or grit. Under the shale is a thin layer of coal, of only an inch in thickness. Shale, 8 feet.

20.—*Lime Rock.*

This rock is hard and tough, not breaking freely; argillaceous quality; color, dirty gray. It contains no fossils, and is the lower member of the non-fossiliferous limestone deposit—6 feet.

21.—*Compact Slate Clay.*

Resting on the limestone, is a bed of dark-colored shale; where exposed to the weather it falls into a tough plastic clay, and probably suitable for the construction of fire bricks—3 feet.

22.—*Coal—bituminous and slaty.*

This deposit is so intimately associated with the non-fossiliferous limestone, that it may be called the "limestone coal." It is quite an extensive bed, and may be traced wherever this lime rock is found.

Range and extent.

Beginning with this coal on the hills two miles east of M'Connelsville, we find it there of a fine quality and four feet in thickness. It has been opened but a short time, and supplies some of the best coal for domestic use, that is found in that vicinity. The elevation of this bed is estimated at 250 feet above the surface of the river. Near the town, the strata containing the coal have been washed and wasted away by the denudating action of the water in seeking its present channel. It is the same on the west side, where the coal and limestone are distant at least half a mile. From this point, the coal can be traced down the river to Meigs creek, where it lies at a much less elevation, and at the mouth of Wolf creek in Waterford, Washington county, it has sunk to the bed of the Muskingum, This point is about 15 miles southeasterly from M'Connelsville, but not much over 12 miles of east longitude, which will give a dip of about 20 feet to the mile. East and northeast of this town, the coal is found in rather increased thickness, on the waters of Meigs, Olive, Green, and Duck creeks, dipping east and southeast, from their heads to their outlets. West of the Muskingum river, we find the limestone, in the southwest corner of Roxbury township, in the banks of Coal run, a southerly branch of Wolf creek: here the coal is increased to 5 feet in thickness. From thence it is spread out south on to the waters of Little Hocking. On the westerly branches of this stream, in Decatur township, it is seen in beds of three or four feet in thickness, in company with the limestone. On the Ohio river it has become quite thin, and lies near the base of the hills; westerly it appears to run out on the hills of Federal creek. A few miles below the mouth of Wolf creek, it is found in the bed of the Muskingum, and has been worked for many years, during low stages of the water. At Coal run it has been followed under the base of the hill, for several hundred feet, by a drift, the floor of which is only a few feet above the river: here the coal is divided by a seam of slate, a foot thick, above the

slate is a foot of coal, below it, nearly four feet. At Bear creek, ten miles from the mouth of the river, is the lowest point where coal has been dug; but it may probably be found some lower before it dips beneath the bed of the stream. The average thickness of coal, may be estimated at four feet.

23—*Bituminous Shale, and slaty Sandstone.*

Over the coal is a deposit of black bituminous shale, changing to an ash colored shale of about eight feet in thickness; on this rests a deposit or layer of hard blue sandstone, eight or ten inches thick, superimposed on which are layers of slaty sandstone, of an argillaceous texture, containing some mica. The upper layer is quite calcareous, the whole amounting to 12 feet. These beds of shale and sandstone, wherever I have seen it, varying some, however, in thickness, being at certain localities only a few feet. Shale and slaty sandstone, 18 feet.

24.—*Lime rock—non-fossiliferous.*

This rock constitutes the most voluminous deposit of limestone, that is connected with the coal measures of the valley of the Muskingum. It lies in stratified beds, varying in thickness from one to three or four feet. The *upper and middle* portions of the deposit, are pale yellowish, or buff colored, gray, or dark blue. In many places, the rocky layers are separated by beds of *calcareous shales*, which are three or four feet in thickness. The shale beds vary in color from pale blue to ash, and dark or light brown; the whole series is from 40 to 50 feet in thickness; and in some places, especially a few miles above M'Connelsville, it is much more. The buff colored layers, break naturally, into prismatic fragments, and readily decompose on exposure to the weather. The blue colored deposits are more compact, and break into rhombic masses, with rather conchoidal surfaces; many portions contain seams of colored spar. The lower member of the deposit, where it approaches nearear to the coal than usual, is very dark colored, and then frequently contains imbedded crystals of brass colored sulphuret of iron. These are generally cubes, and where the stone is very dark, their bright yellow faces make a striking contrast with the dark hue of the rock; some of the lower beds will not slake when burnt, and may, probably, furnish hydraulic lime. This rock is readily distinguished from the deposits of lime found lower in the series, from the fact of its containing *no imbedded fossil shells;* and may be denominated *non-fossiliferous lime-rock.* The beds of stone marl, found in Washington, Athens, Meigs, and Gallia counties, appear to be associated with this limestone, as they have not yet been found in the hills beyond its western and northern termination; wherever it abounds the ridges are covered with a rich soil to their summits. The bed of the middle, or main branch of Wolf creek, affords a fine view of this rock, where it has cut a channel through the whole thickness of these deposites; and for nine miles above its mouth, the bed of the stream is formed of limestone. One mile east of M'Connelsville, and fifteen miles northwest of the mouth of this creek, the lime-rock lies at an elevation of 250 feet above the bed of the Muskingum. Four miles below the mouth, at Coal run, the bed of the river is a little below the lime-rock, while at the mouth, the water in falling over a mill dam has cut through the strata down to the coal. From this point, it is seen to within a few miles of the Ohio, near the base of the hills, and only a few feet above the

water; varying in this respect, according to the course of the river. The main dip in the rock being from the west to the east, and the course of the river for the last twelve miles, nearly north and south, or on the line of bearing, will explain the difference in the amount of dip between the two places. The last place where the rock is seen in the bed of the river, is at Devall's ripple, five miles above the mouth. East of the Muskingum, the non-fossiliferous lime may be traced from Meigs creek, over on to Olive, Green, and Duck creeks, and Little Muskingum, in Morgan and Monroe counties, dipping down south and east, from near the tops of the hills to the Ohio river. The same bed of coal accompanies the lime, and increases to four and a half or five feet in the heads of Duck creek, in the corner of Munroe county. On the west side of the Muskingum, this deposit can be traced on to the heads and middle branches of Wolf and Federal creeks, in Morgan and Athens counties, to near the waters of Sunday creek, when the fourth fossiliferous lime rock comes to the surface and bassets out on the hill tops west of it. South, it continues down the waters of the Hockhocking, to within a few miles of its mouth, when it dips below the beds of the streams. It is also seen in the western branches of Little Hockhocking, gradually sinking as it approaches the Ohio river. The whole deposit may be estimated at 40 feet.

25.—*Calcareo-argillaceous Shales and Micaceous Sandstone.*

Resting on the lime is a bed of schistose sandstone, of a few feet in thickness, varying in this respect at different places; above which, are deposits of various colored clay-marls. They are the fullest developed on the West branch of the little Hockhocking, on Sec. No. 1, T. 6, R. 11, at Fairchild's mill, in Decatur township, Washington county. This locality is about four miles by land, and six by the course of the stream, from the Ohio river, which, in high floods, backs the water to near the top of the deposits. Here the marl is seen in three distinct beds, of about five feet each. The upper one is of a light ash, or grey color; the middle a dark-brown, and the lower a deep verdigris green. The upper one contains the largest share of calcareous matter, and will afford a valuable article of manure, in the cultivation of the adjacent uplands, which generally hold a large proportion of sand in their composition. The brown will also be valuable, as it falls rapidly into a fine pulverulent earth, on exposure to the air. The dark green, when wet and broken up, passes into a fine pale-blue clay, and will afford a valuable material in the manufacture of potteries.

Range and Extent.

North of this locality, the marl deposits extend to the Muskingum river, across the townships of Barlow, Wesley, Watertown and Waterford, and westerly to Athens county; southerly, the red shales extend as low as Gallia, forming a series of deposits, intermingled with the other rocks, which lie over the main coal deposits. Similar beds are found in Wood county, Virginia, and can be traced on both banks of the Ohio, from the mouth of Guyandot to Fishing creek, and for 20, or more, miles from the river; varying, in this respect, according to the course of the stream. It appears to be confined to the central portions of the basin, and to have been amongst the most recent, or last, deposited strata of that numerous series connected with the coal measures and muriatiferous rocks. In its composition, there is a large share of argillaceous matter, colored with

iron; while some of the beds are so highly charged with lime, as to be properly classed with stone marls. Some of the ash-colored deposits contain fragments of shells, as I am informed by Mr. Jesse Lawton, of Barlow, who has applied it as a manure to thin uplands, with great success. The analysis will be given, with other articles, in the progress of the work. Average thickness, 20 feet.

Agricultural character of the region traversed by the non-fossiliferous Limestone and Marls, West of the Muskingum River.

As a general remark, the whole of this region may be said to be hilly and broken; and yet it contains extensive tracts of level, or very moderately undulating lands, of a rich quality, and producing fine crops of grain and grass. The uplands, where uncultivated, are clothed with a heavy growth of forest trees, chiefly of the various species of oak and hickory, with occasional groves and solitary trees of the yellow pine. This species of tree seems, at some remote period, to have held a much higher station amidst its fellows of the forest, than it now does. Extensive tracts, on which the growth at present is altogether composed of other families, are literally strewed with the knots and hearts of the pine, from which, in many places, tar is manufactured in sufficient quantity to pay the first cost of the land. At this day, its growth is almost wholly restricted to the chocolate-colored soils embraced in the range of the red shales. It has been remarked, that a soil congenial to the yellow pine, is one of the most productive of wheat, being generally more calcareo-argillaceous than sandy; where the marl crops out in the sides of hills, in cultivated fields, it is discovered, not only by the redish color of the soil, but also by the deep rich green and luxuriant growth of the Indian corn, wheat and grass. West of Washington county, between the waters of Wolf and Federal creeks, the coarse sand-rocks which lie over the limestone and marls, rise into lofty ridges, and the character of the soil changes, becoming more sandy and loamy, with a forest growth of yellow oak, chesnut and poplar. This variety of soil has a decided influence on the temperature of the atmosphere; ameliorating and warming it in the spring and autumn, and thereby protecting the blossoms of fruit trees and tender vegetables from the ill effects of untimely frosts, a matter of no small importance to an agricultural people. It may be satisfactorily accounted for, in the greater facility with which an arenaceous soil absorbs caloric by day and radiates it by night, than that of an argillaceous quality. It is finely illustrated in the tobacco plant, where this delicate vegetable may be safely left without cutting, one or two weeks later in autumn, than on soils of a clayey quality. Such soils, on elevated grounds, are also nicely adapted to the culture of fruit trees; and orchards of apples and peaches, planted on these ridges, not only produce larger and finer flavored fruit, but also escape many late frosts in the spring, which entirely destroy the blossoms and embryo germs of trees planted in the valleys between the hills. These remarks I have seen verified in my reconnoissance of the counties of Perry, Morgan and Athens, amongst the ridges in the heads of Moxahala, Sunday, Federal and Wolf creeks. As we approach the eastern branch of Federal creek, the country rises into long lofty ridges, based on a loose open sand-rock, which readily disintegrating into a light sandy loam, affords a soil highly congenial to the chestnut and chestnut-oak, which delight in lofty and dry situations. In all countries, and not less so in the hilly portions of Ohio, the character of the soil may be known, from the

quality of the rocks on which that soil is based; where argillaceous sand-rock and shales abound, the soils are of a clayey character; where lime-rocks prevail, the soil will be of a dark color, loamy texture and very fertile, supporting a growth of forest trees on the sides and tops of the highest hills, similar in species to those of the richest alluvions, while a thin, fissile, slaty sand-stone, so hard in its texture, that no influence of rain or frosts can cause it to disintegrate, affords a soil on which nothing can grow but stinted scrub-oaks and the native vine of the hills: such is character of the soil in some of the highest ridges in the southwest corner of Athens county, while in the northeast portion, on the heads of this creek, the hills, although lofty, are clothed with heavy forest trees, and coated with a rich, black calcareous soil. For this advantage, they are indebted to the lime-rock which crowns their summits, and imparts a fertility to the creek alluvions, fully equal to those of the Ohio river. As we approach the Hockhocking river, the ridges and hills become still more elevated, not from any actual rise in the surface of the country, but from the beds of the streams being sunk deeper. This peculiarity is common to all the region embraced in the coal measures, and of itself is a convincing proof that the surface was, at some remote period, nearly a uniform and level country. The bottom lands on the Ohio and Muskingum rivers, which skirt the district on the southeast, are noted for their fertility, and afford some of the most productive farms in the State.

Fossil fresh water Shells.—Bed of ancient Lake.

On Mr. Lawton's farm, in Barlow township, Washington county, in the midst of the marl region, is a locality of fossil fresh water shells, of the genus unio. They are embedded in coarse sand or gravel, cemented by ferruginous matter. The specimens are casts, replaced by an argillaceous oxide of iron. The spot in which they are found, has once evidently been the bed of an ancient lake or pond. It is now a beautiful valley of a mile or more in width, by four miles in length, surrounded by low hills. On the south side, a small branch drains the superfluous water into the Little Hockhocking. In digging wells for domestic use, in this tract, beds of sand, gravel and plastic clay, are passed to the depth of 30 feet, containing imbedded branches of trees, leaves and fragments of wood, of recent and living species. Similar valleys and levels are found in the uplands of the western part of the county, lying between the head waters of the creeks, and are a kind of table land. From the frequency of these flat lands between the head waters of the Little Hockhocking and the south branch of Wolf creek, it is quite possible that, at some remote period, the waters of Wolf creek were discharged into the Ohio river, instead of the Muskingum. This opinion is strengthened from the fact, that the head branches of the south fork now rise within two miles of the Ohio, and run northerly, parallel with, and opposite to, the course of the Muskingum for 12 miles, and join that river, 20 miles from its mouth. The remains of its ancient beds would form pools and ponds of standing water, furnishing fit residences for the fresh water shells, whose fossil remains are now found there. Great changes have, evidently, been made in the direction of all our water courses, before they found their present levels.

Fossil contents of the red Shale.

The fossils found in the calcareous shales, are generally of vegetable origin, consisting of the casts of stems, and impressions of the foliage of

coal plants. These are generally of the family of filices, or ferns, arundinacea, and aquatic plants. Of the former, many well preserved specimens are found in the shale at the "Grotto of Plants," two miles below Marietta, and also at Barris's cave, below the mouth of Big Hockhocking. I have not noticed any fossil shells or animal remains.

26.—*Slaty and compact Micacious Sand-stone.*

Above the lower calcareous shales, lies a deposit of slaty sand-stone, supporting a bed of slaty shale, containing nodules of argillaceous ore, on which rests a deposit of coal. This deposit is more fully developed in the township of Roxbury, range No. 11, township 8, and section 6, than at any other place where I have seen it. Near Marietta, these slaty sandstones lie near the base of the hills. They vary in thickness, at different places, but may be estimated at twenty feet.

27.—*Coal.*

Resting on the slaty shale, we find a bed of coal. It is of a poor quality, containing veins or layers of slate, with considerable sulphuret of iron. It varies in thickness, from a few inches to two feet,—and is one of the last, if not the very last deposits of coal in this part of the valley. About 100 feet higher in the series, in a coarse sand-rock, we find a deposit of dark carbonaceous matter, which probably was the result of vegetable decomposition, similar to fossil charcoal. The coal extends over a considerable space, and can be traced from the southerly branches of Wolf creek, across the Muskingum river, to Duck creek. It may be estimated at 18 inches.

28.—*Sand-rock.*

This deposit extends for a long distance near the base of the hills bordering the shores of the Muskingum and Ohio rivers. On the latter stream, it is often seen in mural precipices rising to the height of 59 or 60 feet; especially above the mouth of the Hockhocking, and at various other points between that place and the mouth of the Muskingum. It stretches westerly and northerly across the county of Washington, into Morgan, and southerly into Athens and Meigs, rising into lofty hills about the mouth of Shade river. The structure and external character of the rock is somewhat various at different places, changing from a loose gravelly conglomerate to a compact sand-stone. Some portions of this deposit appear to be made up of the broken fragments of the secondary and carboniferous rocks—and we find imbedded fragments of bituminous coal, round masses of argillaceous sand-stone, slate clay, &c. scattered here and there amongst the sand and gravel, which enter into the composition of this rock. A section of the strata, from the river bank to the tops of the hills, was taken at the outlet of the Hockhocking, 16 geographical miles south of Marietta, but 25 by the course of the river, and at one or two intermediate places. At Barris's grotto, a beautiful cavern, just below the mouth of this river, we find this rock resting on a bed of argillaceous shale, and composed of loosely aggregated puddingstone, or very coarse sand, containing very small pebbles and coarse gravel, cemented by tufaceous lime, which, as the rock crumbles away by the action of the atmosphere, frosts, &c., falls out in thin layers. Mixed

with the gravel, are small fragments of madrepore, and bits of carbonized wood. This portion of the deposit makes about 18 feet. The upper portion is a compact, rather coarse sand-stone, composed chiefly of silicious sand and clay. It lies in heavy masses, and where there are natural crevices passing vertically through the deposit, it often falls out in large blocks, and is seen lying at the base of the cliffs. These are split into oblong squares, for building stone, and furnish a valuable and indestructible material for this purpose, bearing the vicissitudes of the climate without change of texture. The upper portion of this bed, in some places, contains a stratum of coarse, sharp sand, cemented by silicious matter, which would make good filtering stones. The compact portions of the deposit are extensively quarried for cellar walls, range work, bridges, &c., at Marietta—60 feet.

Grottoes and Caverns.

The lower portion of this rock, where it is composed of coarse materials, abounds in grottoes, some of which are large and very beautiful. The most extensive and perfect of these are near the mouth of the Hockhocking, but are common from there to the outlet of the Muskingum, and seem to be formed by the joint action of air and water. There is, generally, a small stream pouring over the face of the grotto, and often falling from the height of 30 to 40 feet. The roofs and sides are sometimes beautifully ornamented with natural fret-work, resembling the cells in a honey comb, and are usually 4 or 5 inches deep and 3 or 4 broad. They seem to be formed from the wasting away of the sandy portions of the rock, while the argillaceous retain their places. This is effected by a beautiful natural chemical action; small crystals of the nitrate of lime form on the surface of the rock, and throw down the sand, grain by grain, until a cell is formed. The face of the cliff is often ornamented in the same tasteful manner. The "Laurel Grotto" is situated on Mr. Gill's run, a mile from the mouth, and is 20 feet in depth, 100 feet in length, and in front 30 feet in height, forming a semi-circle, and resembles a half section of the interior of a regular architectural dome; over the roof of this dome the water pours, after showers, with great force, on to a floor of slatey argillaceous sand-stone. A little higher up the stream, immense cliffs line the sides of a deep chasm, at the head of which is another grotto and a water-fall of 40 feet. The cliffs here are clothed with hemlocks, (*abies canadensis*,) and the kalmia latifolia; a wilder and more romantic spot can hardly be imagined, rivaling, in beauty and grandeur, the cliffs of Queer creek.

29.—*Argillaceous Sand Rock.*

Resting on the cavernous sand-rock, we find a bluish-colored hard rock, with a finer grain. It contains but little mica, and affords a good material for architectural purposes, but does not work in the quarry so easily as the upper part of the rock below it. The superior strata in this bed are of a slaty structure, or are deposited in layers of a few inches, some of which make a good paving stone for side-walks. This rock can be traced along the hill sides for many miles, both on the Ohio and Muskingum, and is worked at several places for materials in constructing the locks and dams now erecting in the latter river. The thickness varies from 20 to 30 feet. The value of both these rocks, for architectural purposes, is much enhanced, from the fact of their containing *no fossil vegetable remains*, which are common to all the sand rocks below these, in the

coal series West of the Muskingum. They seem to have been deposited posterior to the grand era of the coal formation. This deposit may be estimated at 20 feet.

30.—*Fine-grained stratified Sandstone.*

Color, light bluish gray; contains but little mica in the body of the stone, but considerable in the seams which divide this deposit into layers of great uniformity of surface. They vary in thickness from a foot or more to two inches. The bed and surface faces are very smooth, and require but little dressing to fit them for rounding into grindstones, to which use this deposit is found to be finely adapted. Many hundred grindstones are annually manufactured from this rock in the township of Warren, a few miles below the mouth of the Muskingum, and sent to the towns West and South on the Ohio. This portion of the series may be estimated at 25 feet.

31.—*Yellow, Ochery Shale,*

Containing nodules of the red oxide of iron scattered through the bed. This ore is seen on the hill sides, at various places, but is not sufficiently abundant to be valuable—4 feet.

32.—*Micaceous, slaty Sand-rock,*

In layers of a few inches thick—contains a large portion of white mica, splitting, on exposure to the weather, into thin laminae, and crumbling into a light colored clayey soil, which often crowns the tops of the lower hills, near the rivers. The deposits above this, on many of the ridges bordering the outlet of the Muskingum, have been wasted away, either by the action of the water in seeking its present level, or from the denudating effect of rain and frosts. Some of the higher ridges still retain them. It may be estimated at 40 feet.

33.—*Red Shale*

Near the tops of the hills, a little back from the rivers, we find almost everywhere a deposit of red shale, containing flat and kidney shaped masses of red oxide of iron. It is a rich, heavy ore; the specific gravity of some specimens being 4, 16. It approaches a haematite, and affords a tolerable material for burnishing. This deposit is found in all the hills from below the mouth of Shade river, to above Marietta. In the townships of Olive and Lebanon, in Meigs county, bordering the Ohio, it is said to be deposited in beds of several feet in thickness. I have seen the ore, but have not visited the locality. The deposite of red shale may be estimated at 8 feet.

34.—*Slaty Sand-rock*

At "Barris's Grotto," just below the mouth of the Hockhocking, the hills rise to 80 or 100 feet higher than those near the mouth of the Muskingum. The upper strata are composed of slaty, argillaceous sandstones, varying from a foot to a fourth of an inch. These deposits crumbled down and, mixed with vegetable matter, compose the soil on the tops of the higher ridges.—Thickness, 80 feet.

Remarks.

The rock just described, appears to be the most recent, in that long series of deposits, which were made west of the Muskingum, above the calcareo-silicious rock. As to the diluvial, or alluvial beds, which were probably formed on the coal-measures, near the time of the receding of the ocean from this part of the valley, they have been long since wasted away by the degraing forces which cut down the beds of the rivers to the depth of three or four hundred feet, and furrowed the whole face of the country into those uneven surfaces now displayed in the ridges between the streams. No earth is seen on the hills, but such as may be formed from the disintegration of the rock strata on which it is based.

Salt Springs.

Early history of the Salt Manufacture in Ohio.

Muriate of Soda, or common Salt, is so intimately connected with the economy and comforts of civilized man, that a short sketch of its early history, (although in a manner foreign to a geological report,) and of its manufacture in Ohio, can hardly fail to be interesting, and worthy of our notice. As a branch of the geology of the State, there is no portion of it more vitally connected with the welfare of the people, than those deposits which furnish the materials for our salt wells.

From the period of our first organization as a member of the Union, the "*Salt Springs*" arrested the attention, and received the fostering care of our legislatures. Even before we had become a State, and were yet "a territory," the great value of the Salines had attracted the notice of our most sage and prudent citizens; and, in the compact made with Congress, distinct and express stipulations were entered into for setting apart the most noted salt springs, and a considerable territory around them, for the benefit of the State; they being considered as too valuable to fall into the hands of individuals, who might create a monopoly. At the present period, when culinary salt is so cheap an article, it may seem strange to us, that our fathers should have been so careful to preserve salines, the waters of which were so weak as to require six hundred gallons to make fifty pounds of salt. But when we remember, that at the period referred to, before this territory became a State, the price of salt varied from four to six dollars a bushel, and that the larger portion of it was brought across the Allegheny ranges of mountains, on the backs of pack-horses, we need not wonder at the high value placed upon these saline waters. At that time, they were the only ones known in Ohio, and it was not even suspected or imagined, that at the depth of a few hundred feet, many portions of the valley were based on a rock, whose interstices were filled with exhaustless quantities of brine, of such strength that one twelfth part of the quantity would make a bushel of salt. This article, so valuable, and so scarce in those early days as to be looked upon almost as a luxury, has since been so abundant as to sell for half a cent a pound.

The all-wise and beneficent Creator, who formed this earth for the habitation of man, has stored it with all things necessary for his comfort and happiness. Geology has disclosed the interesting fact, that in every region remote from the Ocean, He has deposited in the rocky strata of the earth, vast magazines of salt. The interior of Africa, Asia, Europe and America, contain, either in the form of rock or native salt, brine springs,

lakes, or efflorescences, an ample supply for the wants of all the inhabitants.

Portions of the valley of the Ohio, if not the whole of it, from its north eastern extremity to its western outlet, may be said to be based on saliferous, or muriatiferous rocks, affording an abundance of water highly charged with the muriate of soda. There are many evidences of its stretching along the western and northern base of the Allegheny range of mountains, amidst the coal and sand-stones of that region, and extending as far north and west as these interesting formations are found. If the salt-rock extends as far north as Lake Erie, of which there are some indications, it probably lies at a considerable depth. Near the Ohio river, the strata which lie over the muriatiferous rocks, consisting of alternate beds of sand-stones, lime-stones, coal, quartz-rock, slate clay, marls, shales, &c. in various modifications, amount in thickness to more than twelve hundred feet. This great accumulation of deposits is made up of distinct beds, which increase in number and in thickness as we proceed south, but grow thinner and crop out on the surface, one after the other as we travel north and west from the Ohio river. From this arrangement, the muriatiferous rocks are reached at a less depth near the margin of the basin, than they are towards the center. The remark is confirmed on the western and northern sides of the coal measures in Ohio, by facts connected with the boring of salt wells.

Remarks on the Salt producing Rocks.

The rock which furnishes the most salt water, and perhaps the only rock which contains muriates, is a white, porous sand-rock. It, however, in some places, has a redish appearance; the color being ascertained from the fine powdery sediment brought up by the tube, used for this purpose, and by the workmen called *"a pump."* On the Muskingum, near M'Connelsville, there are two distinct strata of this rock, known as the upper and lower salt-rocks. The distance between them is over four hundred feet. The upper one is about twenty-five feet in thickness, and affords much less brine than the lower bed. The lower rock is forty feet in thickness, and not only furnishes a stronger water, but also an unlimited quantity. It is of a loose, porous structure, and often contains cells of several inches in diameter, through whieh the auger passes in boring without any resistance, indicating that portions of the rock had wasted away, and left it of a heavy honey-comb structure. A similar condition of the lower salt-rock has been noticed at the works on the Kenawha, Hockhocking, Leading creek, and several other places. At what depth, or in what particular rock the marine or fossil salt is *actually* placed, which furnishes the brine springs, as yet remains in doubt.

The rook in which the main saline waters are found, as stated above, is a white sand-rock of little density, and easily pierced by the drill of the well-borer. Whether particles of marine salt are imbedded and scattered through this rock, and gradually dissolve, as the fresh water from the beds above percolates slowly through it, or whether from its porous quality it imbibes and holds the brine from some rock lower in the series, is at prseent unknown. No fragments or particles of rock-salt have ever been brought up amongst the ditritus or "sludge" of the borings, as I have been informed by the workmen. The specimens of this rock in my possession, appear to be composed of a fine, light colored, silicious and micaceous sand. Whether these borings show the natural texture of the rock, or

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"The Scioto Saline."

This ancient and noted saline lies near the center of Jackson county, on an eastern branch of Salt creek, a tributary stream of the Scioto river. Many of the old furnaces and wells may be said to have been seated within the boundaries of the present town of Jackson. It is amongst the earliest known salt springs in the western country, and may be ranked with the "Big Bone, and Blue Licks," in Kentucky, for antiquity, from the fact of the fossil bones of the Mastodon and Elephant being found at the depth of thirty feet, imbedded in mud and clay. The remains of several of these extinct animals were discovered in digging wells for salt water, along the margin of the creek, consisting of tusks, grinders, ribs and vertebrae; showing this creek to have been a noted resort for these huge mammalia at very remote periods. When the white hunters and traders first came into the country, it was visited by thousands of buffalo or bisons, deer, bear, and nearly all the wild animals of the forest, who found the saline waters agreeable to their tastes, or perhaps needful to their health. So numerous, and so constant were the animal visitors of these springs, that at certain seasons of the year, the country adjacent was the most valuable and profitable hunting ground which the savages possessed. They were also in the practice of making salt here from very remote times, as has been ascertained from several of their white captives, who had visited them in company with the Indians. The first attempt at its manufacture by the whites, was after the close of the Indian war, in the year 1797. At that time, and for several years after, the stumps of small trees cut by the squaws, and the charcoal and ashes of their fires, where the salt water had been boiled, were plainly to be seen. The Indian women, upon whom all the servile employments fell, collected the salt water by cutting holes in the soft sand-stone in the bed of the creek, in the summer and autumn when the stream was low. These were generally not more than a foot or two deep, and the same in width. Into these rude cavities the salt water slowly collected, and was dipped out with a large shell into their kettles, and boiled down into salt. The hunters and first salt makers, pursued the same course, only they sunk their excavations to the depth of six or eight feet, and finally to twenty feet into the sand-rock, and excluded the fresh water by means of a "gum," or section of a hollow tree, sunk into the cavity. After a few years, they commenced digging wells a little higher up the stream, in the alluvion, or bottom lands, near the creek, and to their surprise, found they could dig to the depth of thirty feet, before they came to the sand-rock, which, a few rods below, filled the whole bed of the stream.

Extent of the manufacture.

The greatest quantity of salt made at the Scioto licks, was from the year 1806 to 1808, when there were twenty furnaces in operation, making, on an average, from fifty to seventy bushels per week. During this period, it was worth $2.50 per bushel, or five cents a pound. These furnaces were located along the borders of the creek for the distance of four miles. At one time, there were fourteen furnaces in operation near the town of Jackson. At that early day, the roads were generally mere "bridle paths" through the woods, and nearly the whole amount of salt made was transported in bags, on pack-horses, and distributed through the middle and western portions of the State.

Early legislation on the Salines.

That we may understand the high value placed on the Salines, both by Congress and the people of Ohio, it will be proper to revert to the legislative acts on this subject, and to know that the grant was made with express stipulations that the State should *never sell them*, nor lease them for a longer period than *ten years* at any one time. In the year 1803, amongst the earliest proceedings of our legislators, we find an act regulating the leasing and the managing of the "Public Salt Works." An agent was appointed to take charge of the lands, to lease small lots for digging wells and erecting furnaces, and to see that no individual or company monopolized the manufacture of salt. To prevent which, it was expressly enacted that no one person, or company, should work more than 120 kettles, nor less than 30. For this privilege, the lessee paid a rent to the State of twelve cents per gallon on the amount of capacity of his kettles, annually. A fine of $5 per kettle was laid on every person who made salt without a license. The agent himself was forbidden to engage in any way in the manufacture of the article. In the year 1804, the rent was reduced to four cents per gallon, and the amount limited to 4000 gallons of capacity. In 1805, the rent was again reduced to two cents, and in 1810 to 5 mills. At this time, a much stronger water had been obtained on the Kenawha, by boring into the rock strata to the depth of one hundred feet. In February, 1812, the Legislature appropriated $300 to defray the expense of boring two hundred feet; and in 1813, they appropriated $1500 for the same purpose, which does not appear to have been expended. In 1815, the State ordered 750 dollars, to pay the expense of boring to the depth of 350 feet, under the direction of Wm. Givens, with a proviso that the water procured must be of such strength as to make 50 pounds of salt from 250 gallons of brine. It seems that Mr. Givens executed the work faithfully, and then added another 100 feet to the depth on his own expense, as I am informed by Mr. Crookham, who was amongst the earliest of the salt makers, and from whom much of the history of the first proceedings in digging wells, &c. was obtained. At this depth, viz. 450 feet, the boring ceased. A stronger water was procured, but it was in small quantity, and did not rise to the top of the well; probably from a deficiency of carburetted hydrogen gas, which, at several other works, rises in great volume, and forces the water for many feet above the surface. "Forcing pumps" for raising the water were not then in use, as they now are, at the various salines. No less than 15 acts were passed on the subject of the Scioto Salt Works, while under the control of the State.

The "Delaware Salines."

This ancient saline was located in Delaware county, Brown township, quite without the margin of the coal measures. At this reservation it does not appear that much salt was ever made, as only four or five acts were passed in relation to it. In 1809, Moses Bixby applied for leave to make certain improvements, and to manufacture salt at that place, which was granted. In 1817, a lease of the Delaware lands was given to Jos. Eaton, on condition of his making improvements thereon, amongst which was a a salt well, or boring of 200 feet in depth, which he completed, and procured salt water of such strength, that 200 gallons made 50 pounds of salt. The quantity, however, was very limited; and, in 1818, he bored one

hundred and one feet deeper, but, at 288 feet, struck a rock so hard, that he only penetrated thirteen feet in three months, with the labor of three and four men daily. After this time, it seems that no further attempts were made at the salt manufacture. These springs appear to rise in a similar formation to those of the Greenbrier valley, in Virginia, viz., a carboniferous limestone. There, several weak muriate of soda springs are found by boring; but these deposits are more celebrated for their sulphur springs, than for those of salt water.

The "Muskingum Salines."

These salines were located on Salt creek, in the present Salt creek township, Muskingum county. An agent was appointed for the Muskingum Salines as early as 1804, but no law regulating them was passed until the year 1809. The brine here, from a boring of 300 feet, was of such strength as to require 250 or 300 gallons of water to make 50 pounds of salt. Two or three furnaces were in operation for several years. Stronger water being found on the Muskingum river, they were abandoned about the year 1820. At this location, the famous "*silver mine*" experiment took place in the same year, and the sum of 10,000 dollars uselessly expended by the "Muskingum Mining Company;" all which expense and chagrin, with our present knowledge of geology, might have been avoided.

In the year 1826, after obtaining the consent of Congress, all the "salt reservations" were finally sold. They had, for several years, been a bill of expense to the State, and afforded no profit to the lessees, as salt could be made much cheaper at the stronger salines on the Big Kenawha and Muskingum rivers.

Gallipolis Salines.

This saline is seated on Chickmogo creek, a little below Gallipolis, and was the next in point of time, where salt was made in Ohio. It was commenced by Mr. Fletcher and General E. Tupper, in the year 1807. The brine varied but little in strength from that of the Scioto saline, from which it is distant about 30 miles in a S. E. direction, and required about 600 gallons to make 50 pounds of salt. In 1809, these enterprising men penetrated the rock strata, by boring to the depth of 100 feet, and procured a stronger water, 400 gallons of which yielded a bushel of salt. This was the earliest attempt ever made in Ohio, at boring the rocks in search of water. The first that was made West of the mountains, was in the year 1807, on the Big Kenawha, by Col. D. Ruffner. After this time, wells were sunk at this saline to the depth of 500 feet, but the brine procured never required less than 200 gallons to the bushel. Several wells were sunk, and furnaces erected, by different persons, and salt made there, until within bout a year. At this period, the manufacture has ceased, unless revived since August last—the superior strength of the water on the Kenawha and Muskingum, enabling the manufacturers there to sell salt for a less price.

Leading Creek Saline.

This saline lies about 35 miles northeasterly from the Scioto saline, and about 18 miles North of Gallipolis, and further within the coal measures. It is seated on Leading creek, in Rutland township, Meigs county. The

first salt well was opened here in the year 1822, by B. Stout, Esq., at a point about 8 miles above the mouth of the creek. It had been, from the earliest knowledge of the hunters and first settlers, a noted lick for wild animals in the summer months. Hamilton Kerr, a celebrated ranger, had made salt here in the year 1796, by boiling the water in his camp kettle, collected by diging holes in the sand, at a time when the creek was nearly dry. Four other wells have been bored since Mr. Stout's; three below him and one above. The average depth of the wells is 450 feet. The calcareo-silicious rock dips below the beds of the streams in Wilkes township, about 12 miles West of the Salines, and is said to be reached at the depth of 180 feet below the surface, or bed of the creek, which would only carry the wells to the upper saline rock. At Mr. Stout's well, a bed of coal was passed at less than 100 feet, which is said to be six feet in thickness. Directly after piercing the coal, the auger opened a fountain of spring oil, or petroleum, which discharged a number of barrels in a day, and continued to come up copiously for several days. The discharge of carburetted hydrogen gas from this well was immense at first, throwing the water to a height of more than 33 feet, as they were putting a tube into the well, for the exclusion of fresh water. The flow at this time, after the lapse of 15 years, is still very copious, and made with great regularity at intervals of about forty minutes; and continuing to throw up the water violently in the well head, or cistern, for about ten minutes at each paroxysm. This singular phenomenon takes place with great regularity, and has been measured accurately with a time-piece. The gas is eliminated by a natural chemical process, continually going on in the bowels of the earth, and is considered by "well borers" an omen of salt water, as it almost invariably is found near salines, either discharging, through some natural crevice in the rocks, where it is called "*a burning spring*," or rising with the brine in the salt wells. The water at this saline is a stronger brine than that farther West, and nearer the margin of the coal basin. It requires rather more than 100 gallons for 50 pounds of salt. The "Pomeroy coal bed" is here found at an elevation of about 150 feet above the creek, and six feet in thickness; affording a valuable article of fuel in boiling the water. At a well four miles below Mr. Stout's, the boring was continued to 800 feet, without any additional strength to the brine, or increase in quantity.

The Hockhocking Valley Salines.

As we proceed, easterly, from the margin of the coal measures, the next salines are found in the valley of the Hockhocking. The earliest indications of which, it is said, were observed in the crystallization or efflorescences of salt on the sand and stones in the bed of the river, at low stages of the water during the summer months. A well was first bored by J. Pugsley, about the year 1820, in the township of Dover, Athens county, on a small run, three or four miles from the mouth of Sunday creek. Since which, two other wells have been sunk, one a little above the mouth of the creek, on the bank of the Hockhocking, and one six miles north on a small branch that falls into Sunday creek. The water in the wells located on the small branches, is less copious than at the one near the shore of the river; confirming the remark which has before been made, *that large streams of water are necessary in the immediate vicinity of salt wells, to insure a full and free supply of brine.* At the well, one mile above the mouth of Sunday creek, on the bank of the Hockhocking, the water is discharged with great force and freedom, rising in "the well

head" twenty feet above the surface of the river at common stages of the water, and running in a constant stream at the rate of 12,000 gallons in 24 hours; a free discharge of carburetted hydrogen no doubt accelerates the rise of the water from the cavities in the rocks below. It is estimated that this well affords sufficient brine for 110,000 bushels of salt in a year; with their present single furnace, about 40,000 bushels are now made. The water at these salines is considerably stronger than at those West of of here, containing over ten per cent. of muriate of soda, and making a very pure salt, but little deteriorated with muriate of lime or "bitterns." This per cent. will require nearly 75 gallons of brine to 50 pounds of salt, which is about equal to the Kenawha water. The average depth of the wells in this vicinity is rather over 530 feet; from which it would seem that the boring was commenced some distance below the calcareo-silicious rock, as no similar rock is passed, on inquiring of persons who were engaged in the work. We find a like dip in the rock strata here, to that on the Muskingum, as we proceed southeast down the river, so that at Stroud's run, seven miles East, and four miles South, making about nine miles in a S. E. direction, it requires a depth of 800 feet to reach the salt rock. A boring was recently made for salt water nearly opposite to the village of Nelsonville, ten miles above the mouth of Sunday creek, to the depth of 630 feet, but without success. Twelve miles above this point, the conglomerate which underlies the coal measures, is seen lying in the bed of the river, seeming to indicate that the muriatiferous rocks are unproductive near the margin of the coal basin. Some of the finest beds of coal in the State are found in the vicinity of these salines, and are in use as a fuel at the salt furnaces. The Hocking Valley Canal passes directly through these rich deposits of coal and salt, and must ultimately make them of immense value to the proprietors, and to all the interior of the State, where these products can be transported on the canals, which, like the vessels of the human frame, will, in a few years, meander through all parts of the body of the republic, carrying health and strength to every member.

Salines of the Muskingum Valley.

The most valuable portion of these muriatiferous waters are located in Morgan county, along the margin of the river, and about 25 miles northeast from the last described salines. Here we approach nearer to the centre of the coal basin in Ohio, and find a corresponding increase in the strength of the salt water. It has not yet been satisfactorily ascertained how far up the Muskingum river and its branches the saline deposits extend; but certainly as htgh as Coshocton, and probably as far north as the south line of Stark county, as salt water is abundant on Yellow creek, east of this point, and from thence downward to the mouth of Bald Eagle creek, on the south side of Morgan county. All along this line, a distance of 60 geographical miles, the saline rocks are found gradually sinking deeper and deeper into the centre of the valley from a depth of 250 feet to that of 1,000. At Zanesville salt water is obtained at 350 feet. At Taylorsville, nine miles below, at 450 feet. At M'Connelsville, eighteen miles further southeast, at 750; and at Bald Eagle it is nearly at 1,000 feet. The strength of the brine increases in about the same ratio, so that 50 gallons from the lower wells afford as much salt, as 250 from the upper ones. By an analysis of the water, from R. P. Stones well, near M'Connelsville, made by Proffessor Mitchell, it yielded as follows—viz: from four ounces there was obtained,

Of Muriate of Soda,	- - - - - -	269 grains.
Muriate of Magnesia,	- - - - - -	20 grains.
Muriate of Lime,	- - - - - - -	15 grains.

It also contained some carbonate of iron, and showed a point trace of iodine. From this analysis the water affords nearly 14 per cent. of salt, besides the other muriates. The water from the lower well at Bald Eagle is supposed to be still more fully saturated. The first well sunk on the Muskingum river, was near the mouth of Salt creek in the year 1817, since which period up to the present time, there has been bored sixty-one wells, to which are, or have been attached nearly as many furnaces; but a large number of them are now out of use. Of this series, forty-two wells below Taylorsville, eleven between that place and Zanesville, and eight above Zanesville; three of which are in Coshocton county. As to the annual quantity of salt, at present manufactured in the valley of the Muskingum, I am not fully advised, but suppose it to be about about half a million of bushels; and may be increased to meet the wants of the country. The improvements in the navigation of the river now in progress, will greatly facilitate the transport of this valuable commodity to market, during the summer months, as well as in the spring and autumn,

Petroleum and Carburetted Hydrogen.

These two interesting productions of the beds of bituminous coal which lie deep in the earth, are found to accompany the salt water in nearly all the wells. In some they are very abundant; in others, the quantity is so small as to be barely perceptible. Where gas is discharged freely, it greatly assists the ascent of the water in the well, and saves the expense of forcing it up by the aid of a pump worked either by a horse or steam power. If constant and abundant, as it is at R. P. Stone's well on the Muskingum, it might also be conducted by pipes under the kettles, and used as a fuel in boiling away the brine, thus relieving one of the heaviest items of expenditure in working a furnace. In some wells the discharge of gas is periodical, and at intervals of eight or ten days, bringing up with it large quantities of petroleum, to the amount of several barrels. This is the fact with a well in Olive township, on the east side of Morgan county, and west branch of Duck creek, twenty miles east of M'Connelsville; at this well the discharges of gas are tremendous, throwing the water all out of the well to the height of thirty or forty feet. These eruptions are attended by a flow of petroleum, which, for the first few years, amounted to from thirty to sixty gallons at each paroxysm, and returning at intervals of two to four days. They are now less frequent; and the discharge of petroleum is about a barrel per week. The well was bored in the year 1814. For the collection of such vast quantities of gas, there must be corresponding cavities, in which it may be treasured up until they become so full as to overcome the resistance of the superincumbent water, and force a passage to the surface. Collections of the same nature sometimes take place in the earth at a distance from the rivers or salt wells. At a locality near the gravel coal beds on the Hockhocking, the earth and rocks have been blown out to a considerable distanee, leaving a cavity of several feet in diameter and depth. Probably the true reason why saline fountains are commonly attended by inflamable gas, is, that the coal formation, and salt deposits are, geologically, close neighbors, the salt being usually above in Europe and other countries, but not so in the valley of the Ohio, or in the valleys of its confluent

streams. It appears from the facts noted in these remarks, that the main salt rock lies below the coal. This compound gas is the same with that which collects in such quantities in the coal mines of England, and by its explosion proves so destructive to the lives of the miners.

I have not yet visited the salines on Big and Little Yellow creeks, and am not prepared to give a description of the improvements there.

S. P. HILDRETH,
First Assistant Geologist, and Paleontologist.

REPORT

OF

DR. KIRTLAND,

SECOND ASSISTANT GEOLOGIST.

No. 3.

CINCINNATI, *December* 3, 1839.

To Professor W. W. MATHER, *Chief Geologist:*

SIR: In pursuance with the letter instructions, which I had the honor to receive from you, bearing date "Columbus, June 23d, 1837," I proceeded forthwith, "to collect and arrange, in a scientific manner, the various objects of the recent animal and vegetable kingdoms in this State."

I am happy to inform you, that I have progressed so successfully with most of the branches belonging to the departments assigned me, that my catalogues already afford evidence, that Ohio is rich in species, so far as Zoology and Botany are concerned.

As the People generally appear to feel a deep interest in the success of the undertaking, and we are indebted to the public spirit of their Representatives, for its commencement, and support; and it is due to them, that they should be informed of every circumstance, in regard to both its progress, and anticipated results.

With this view, you will permit me to notice some of the advantages that are expected to arise from investigating the several branches committed to my charge. It is designed to make out as full and perfect catalogues as possible of all our Animals, from the minutest insect and reptile, to the largest mammalia, and of all our vegetables; arranging them according to their classes, families, orders, genera and species; giving each both its scientific and common name, and at the same time noting any peculiar or important character it may possess.

Also, to collect and prepare specimens of the various species, as far as practicable, for the use of the State. If suitable means be taken, afterwards, to preserve them, they will compose a standard Cabinet, to which all classes of citizens can resort, either for amusement, or for the more profitable pursuit of acquiring a knowledge of the Natural History of this section of the country. And although it cannot

be expected that one individual will be able to make out a perfect collection, during the time that will probably be allowed for completing the Geological Survey; yet it may be made so extensive as to form the basis or nucleus, to which additions will be constantly made, by the labors of naturalists, who will be stimulated to exertion by the collection already formed.

The study of the several systems of Natural History is peculiarly calculated to discipline the mind, and it is desirable to introduce it as a branch of education among the rising generation. This can be done in no manner so effectually, as by laying the foundation contemplated in making such a collection. It will afford facilities for pursuing the study in every portion of the State.

The names and terms employed in these branches may appear dry and uninteresting to any except the votaries of science, yet we daily see the want of a knowledge of them, in the confusion that arises from popular names and descriptions of natural productions. "A striking instance of this may be found in the celebrated Kotzebue's narrative of his banishment to Siberia, in the course of which he discovered a plant, which attracted his admiration, and which he has described *at great length*, as one of the most beautiful flowers he had ever met with. A very moderate acquaintance with botanical science would, however, have informed him, that this plant, if one may venture to form a judgment from his account of it, was already known to most parts of Europe by the name of *Cipripedium;* and the only doubt which remains is, as to the particular species of the plant, a doubt which his description, does not, after all, enable us to clear up."*

A correct application of half a dozen terms would have decided the point with so much certainty, that if that plant were afterwards found in any other part of the world, even the most remote, it would be recognized by Botanists.

Perhaps some may still inquire, Of what practical utility are these investigations? We would reply, that man derives his nourishment and support from the productions of the animal and vegetable kingdoms; but, while some contribute to his comforts and enjoyments, others again tend to interrupt or destroy them.

The Naturalist, by becoming familiar with the habits and characters of these productions, is enabled, on the one hand, to select and appropriate to use those that are valuable; and, on the other, to reject such as are detrimental, or to correct their evil tendencies.

There are, doubtless, many species belonging to both these kingdoms that possess useful properties, that are now neglected, and are rapidly disappearing before the progress of cultivation and improvement. Most of the larger mammalia have already become extinct in Ohio. Forty years since, the Bison (*Bos Americanus*) visited our borders; at this time, few or no Elk (*Cervus Canadensis*) remain, and the common Deer (*Cervus Virginianus*) are comparatively rare. Notwithstanding they all have once existed in great abundance on our

* Roscoe's Address to the Proprietors of the Botanic Garden at Liverpool.

frontiers, it yet remains to be decided by experiment, whether they might not be domesticated, so as to become serviceable as beasts of burthen or as articles of food.

All of our domestic animals were originally as wild, and perhaps as unpromising in their habits as either of these; yet, by a long course of training, and by familiarity with man, have entirely changed their dispositions. We have no evidence, so far as I am informed, to show that the Bison might not be successfully taught to yield its neck to the yoke as well as the Ox. It is said, that in some parts of the East Indies, the Buffalo (*Bos bubalus,*) which is analagous to our Bison, is employed for carrying burthens and for draughts.

The Elk and Deer will, without doubt, be domesticated, as objects of curiosity, if not of profit, as our State advances in improvements and luxury.

There is another family of animals that deserves more attention; I allude to the *fur bearing*, including the Beaver, (*Castor Fiber,*) Otter, (*Lutra Brasiliensis,*) and Musk-rat, (*Fiber Zibeticus.*) The sources from whence the supplies of fur are derived, are principally the northern parts of Russia and northern and western parts of America. The energy with which the Fur Trade has been carried on, for the last thirty years, has rapidly exhausted these sources, particularly the latter; and it is said by those experienced in the business, that they will fall far short of satisfying the increasing demand before the end of twenty years. It therefore becomes an object worthy of enquiry whether some or all of those kinds of animals might not be profitably domesticated for their peltries.

From my own experience, I know that both the Beaver and the Otter will, with a little attention, become as docile and as obedient to the commands of man as most of our *household* animals; and I am convinced that, in localities where abundant supplies of suitable food are found, as great profits might be realized by breeding them as are anticipated from the productions of the Silk-worm in this country.

We are indebted to our native feathered tribes for two important species of barn-yard poultry—viz: The wild turkey, (*Meleagris Gallopavo,*) and the mallard, or green headed wild duck, (*Anas domestica.*) This number might, no doubt, be greatly and advantageously enlarged by other additions from the *Lamellosodentati* and the *Gallinaceæ.*

The same means that have domesticated the aforementioned species would transfer from their native haunts to our yards and fields, the Canada goose, (*Anas Canadensis,*) brant, (*Anas bernicla,*) widgeon, (*Anas Americana*), dusky-duck, (*Anas obscura*), wood-duck, (*Anas sponsa*), teals, (*Anas discors et crecca*), canvass-back, (*Fuligula valisnera*), pochards, (*Fuligula ferina*), and other eatable ducks; the prairie hen, (*Tetrao cupido*), pheasant, (*Tetrao umbellus*), and the quail or partridge, (*Perdix Virginiana*).

The early settlers of this State derived abundant supplies of fish from the different rivers; but of late, many of the finest species have forsaken their resorts, owing in a great measure to the obstructions

occasioned by the construction of so many dams. It is also worthy of enquiry, whether some provision should not be made by law to protect them, so far at least as to make it necessary to provide a sluice-way in every dam sufficient to allow them a free passage up and down the streams, in conformity to their instinctive laws of migration. And also, whether it might not be made a profitable business to construct artificial ponds in favorable situations, for the purpose of breeding the finest kinds of *fish*. In other countries it is often done by turning small streams of water, or by enlarging and improving springs. It may be done here in many situations with trifling expense.

Our reptiles are few, and generally insignificant. I know of none that can be employed for any convenient or profitable use. The venomous species are rare and will soon become extinct within our borders.

Humble and insignificant as are the insect tribes, they materially influence the condition of man. Among those which may be said to be enlisted in his service, the honey-bee, (*Apis mellifica*), is one of the most conspicuous: another is the silk-worm, (*bombyx mori*).

It is not improbable that some of our native *coccoon-spinning* insects may be found to answer as valuable purposes as the silk-worm.

Experiments have already decided that some of the American cantharididæ are at least equal to the foreign species for medicinal purposes.

The list of those insects that may be considered as interrupting the enjoyments of man, or interfering with his comforts, is much more extensive. It embraces, among many others, the wheat-fly, (*cecidomyia destructor;*) the bee-moth, (*galleria cereana;*) curculio, or plum-bug, (*cryptorhynchus cerasi;*) rose-bug, (*macrodactyla subspinosa;*) peach-tree borer, (*ægeria exitiosa;*) apple-tree borer, (*saperda bivittata;*) and the cut-worm, (*noctua præmordens.*) The naturalist, by becoming familiar with their economy, is often enabled to devise means to counteract their injurious tendencies. Mr. Say discovered that a small parasitic insect, the *ceraphron destructor*, infests and destroys large numbers of the Hessian fly, and is, probably, the natural means that restrain the ravages of that enemy to our wheat crops. From my own experience, I know that swine will exterminate, in a great measure, the curculio-bug from a plum orchard, in the course of two or three years.

By knowing the habits of insects, we can often obviate their attacks. The farmer may find it advantageous, in those sections of the State where the Hessian fly is common, to either postpone sowing his seed until the time for depositing the egg of the insect has passed, or to substitute spring for winter wheat; and it is also probable that some of the winter varieties of this grain may yet be found with stalks so solid that they will resist the attacks of this enemy. Many years since, the timber in the navy yards of Sweden was rendered unfit for use by the perforations of a small worm. The Government applied to Linnæus for a preventive of its attacks. He recommended to have the timber sunk in water during the few days that were occupied by the insect in depositing its eggs. The remedy was perfectly effectual,

and, simple as it was, saved more than a million of dollars annually to his country.

The vegetable kingdom opens a wide and fertile field for the inquirer, in the applications of its productions to the purposes of the artist, husbandman and physician.

We know, at present, very little about the number and value of the coloring materials that may be derived from this source; but it is certain that, in many instances, our native dyes, when set with suitable mordants, form as permanent and durable colors as any obtained from the more expensive foreign materials. Many of our indigenous vegetables contain fibrous substances in their wood, bark, roots or leaves, which may, on trial, be found important substitutes for hemp and flax in the manufacturing of cordage, cloth and paper. Of this class are some of the neules, (*urticaria*,) Indian hemp, (*apocynum*,) and milk-weed, (*asclepias.*) Aquatic plants and algæ may yield the best materials for paper; and the silky down attached to the seeds of the common milkweed, and contained in the follicles of that plant, may, perhaps, furnish an important substitute for cotton, feathers, down and fur.

Among our native grasses are some species that would equal or surpass any now in use, if they were selected and cultivated by themselves.

The fine varieties of fruits with which our orchards and gardens abound, are the remote offsprings of the most inferior and unpalatable kinds; the apple sprung from an austere crab, and the peach from a dry, woolly fruit, nearly destitute of pulp. Their improved conditions have resulted from cultivation. It is worthy of inquiry whether the *custard*, *apple*, *papaw*, (*asimina triloba*,) might not be made to break into rich and palatable varieties by artificial means.

Of the numerous native plants already known to possess active medicinal properties, few have been subject to close investigation; and there are very many which contain equally active and probably valu able properties that have been entirely overlooked. The success that has attended the few limited attempts at bringing into use our indigenous medicinal plants, show that it is an important subject; and it is evident that our materia medica might be enriched by the additions of many rare vegetable articles from our forests and fields.

The limits of a report will not allow me to pursue the subject further. This view of it, though concise, is perhaps sufficiently minute to show that an investigation of the animal and vegetable kingdoms may be of great practical utility to the public at large, as well as to science. The arts, agriculture, and science, are so mutually dependant on each other, that one cannot be greatly advanced without a reciprocal advancement of the others.

I would briefly add, that I have already collected and prepared, for the use of the State, numerous specimens in several of the branches assigned to me, which I will forward to Columbus as soon as a safe and suitable receptacle is provided for them.

I am, sir, very respectfully yours,

JARED P. KIRTLAND,
Second Assistant Geologist of Ohio.

REPORT

OF

C. BRIGGS, JR.,

FOURTH ASSISTANT GEOLOGIST.

No. 4.

To Professor W. W. Mather,

Principal Geologist of Ohio.

Sir: In the letter of instructions which I received from you as Chief Geologist of the State of Ohio, dated June 23d, 1837, I am directed to "take charge of the geological investigations which will be made between the waters of the Scioto and Hockhocking rivers"; embracing the counties of Scioto, Lawrence, Gallia, Athens, Hocking, and Jackson; and to report to you the progress of my labors, on the 1st of January, 1838. In obedience to these instructions, I have now the honor to Report:

That I repaired, as soon as practicable, to the district assigned me; and having made a reconnoissance of it, proceeded to the detailed examinations.

As, for obvious reasons, the surveys of particular counties, or districts, cannot be completed until the whole ranges of strata, of which they embrace only a part, shall have been explored, most of the economical facts, collected during the detailed examinations, will be communicated while describing the strata embraced in the reconnoissance. This reconnoissance was made, in order to facilitate the subsequent investigations, by first determining the great geological outlines of the district.

With a view to ascertain the relative position of the strata, their dip, direction, general characters, and economical value, it was found necessary to make several sections in the line of dip, not only across the counties which have been mentioned, but to extend them into Pike, Ross, Adams, and Highland. These objects have been so far accomplished as to determine, with some degree of precision, the general geological features of the State, and the vast extent of her mineral resources.

In accordance with your instructions, it has been constantly borne in mind, in all our investigations, that *practical utility* is the primary object which induced the Legislature to authorize the survey; and, leaving out of view the great benefits which are conferred upon the community by investigations in purely scientific Geology, our examinations have been sufficiently extensive to show, from economical considerations alone, that this enterprize, if conducted to its termination, with that spirit of enlightened liberality heretofore characteristic of Ohio in her appropriations for public works, will not only give a new and immediate impulse to the general interests of the State, and to the individual prosperity of her citizens, by fully disclosing, at an early period, the treasures now concealed in the bowels of the earth, but confer invaluable benefits upon those who will come upon the stage when the present generation shall have passed away.

RECONNOISSANCE.

The strata of that part of the State embraced in the reconnoissance, the boundaries of which have been heretofore described, are composed of nearly horizontal and alternating layers of limestones, sandstones, shales, coal, and iron ores, to the depth of more than two thousand feet. They have been worn down and denuded, in every direction, apparently, by vast bodies of moving water, so as to form irregular hills, valleys, and ravines, giving to the surface the very rugged and uneven appearance which we now observe. There can be no doubt that the strata were originally deposited beneath the surface of an ocean, in nearly horizontal layers;—but as this is not the proper place for theoretical discussions, it need only be observed, on this subject, that this erosive action may have been produced by the elevation of the strata from beneath the surface of the ocean, causing tremendous currents of water to sweep over the yielding rocks in various directions, forming valleys and ravines, and scooping out basins for small lakes, or ponds, which have been subsequently filled with stratified deposits of clay, sand, or gravel. This modification of the surface by water, has not only afforded great facilities for geological investigations, but made easy of access exhaustless treasures which otherwise would have remained concealed in the bowels of the earth.

Dip of the Strata.

Before proceeding to a description of the rocks, embraced in the reconnoissance, some definite notion should be formed of their dip and bearing, and the obstacles which may be encountered in their examination. This is very important, in a practical point of view.

The rocky strata of the district assigned me for examination, consist, as before observed, principally, of limestones, sandstones, shales, coal, and iron ores, superimposed upon each other with parallel planes of stratification. They dip, or are inclined, towards the east, or east southeast; but so slightly, that their inclination is scarcely perceptible

to the eye; excepting where long levels can be taken, on the water courses. This remark can only be applicable to the amount of dip over large areas; for the strata are always more or less undulating, and in a manner calculated to deceive the inexperienced, by local variations, not only in amount, but in direction. For example, the general dip is, perhaps, not more than 30 feet in a mile; while undulations, in some instances, cause it to be more than double that distance. A gentlemen, to whom I am under obligations for much local information, ascertained the local dip, by actual measurement, to be, in one situation, 28 feet in a quarter, or 112 feet in a mile. This undulating character of the strata, which are nearly horizontal, often causes a local dip, not only in the line of bearing, but sometimes in a direction opposite to the true one. From what has been observed, it will be readily seen, that to ascertain the absolute amount and direction over extensive areas, will be a work of difficulty. It is one, however, of much practical importance to the community, as it is a necessary preliminary in successfully tracing the valuable mineral deposits of the State, and directing explorations for treasures, concealed from observation beneath thick masses of materials of little economical value. As this object cannot be effected in situations where the dip can be observed only for short distances, it will be necessary to ascertain its amount in two directions, over considerable areas, or as far as any stratum can be traced before it disappears beneath the water courses; and then, from data thus obtained, to make the calculation trigonometrically. As the rocks are conformable, it is not necessary that the same stratum be used in both directions. This labor will be greatly facilitated by the surveys which have been made by the State, for canals along the valleys and principal rivers. This method of ascertaining the dip over extensive areas, is only an extended application of a principle suggested to me by yourself.

Difficulties in Geological Examinations.

It may be proper here to remark that, although the geology of this portion of the State is exceedingly simple, no inconsiderable difficulties will attend its examination. It is true that the water-courses, in many places, present fine sections of the rocky strata; but they are so worn down by the action of water, and their surfaces so covered by debris, that it is often difficult to trace their continuation from point to point. They undulate irregularly, while their inclination is very slight; and they are so variable, even in short distances, that little reliance can be placed on either external characters or mineral composition. A coarse conglomerate in one place, is a fine grained sandstone in another; a bed which is composed of argillaceous materials, at one locality, at a short distance, may be entirely silicious; and a stratum, embracing coal, iron or other valuable materials in a particular locality, may, in another, be entirely destitute of them. Were it necessary, other examples might be adduced. These have been cited, as they have an important bearing in practical geology; having been impressed upon our minds, by the frequent, and in some instan-

ces, ludicrous mistakes which have occurred, by attempting to refer rocks to their proper geological position, by external characters alone —the only sure criteria being organic remains, and actual order of superposition.

For convenience of description, the strata have been separated into seven groups or subdivisions, which, it is believed, correspond with important eras, or changes, during their deposition. They will be described in the order of their superposition, beginning with the lowest and ascending in the series. Figure 4, of the plate, will illustrate their relative position, as observed in traveling eastward, from Adams and Highland counties, to the Ohio river.

I. The first subdivision, (marked B,) includes the limestone of Adams and Highland counties, and is, probably, merely a continuation of that which forms the rocky strata of the whole western portion of the State. This limestone is of great thickness, and contains, where it has been examined, the petrified exuviæ of radiated and molluscous animals of marine origin, some of which belong to extinct genera, and all to extinct species. These reliquiæ of a former condition of our planet, are so abundant, that the conviction is forcibly impressed upon the traveler's mind, that he is treading upon the floor of an ancient ocean.

Many ages must have elapsed and a peculiar condition of our planet prevailed, during the deposit of this vast mass of carbonate of lime, as it is composed of numerous layers extending to the depth of more than 600 feet,* and contains throughout its whole extent myriads of petrified relics of animals, many of which must have lived and died where we now find them entombed.

II. In this division (vide C, fig. 4, of the plate) there appears to have been an important change, not only in the materials which were deposited, but in their organic contents. Reposing upon the limestone already described, occurs a body of argillaceous slate, two hundred to three hundred feet in thickness, in which animal remains are rare. This slate is thinly laminated, and, according to the rules of geological interpretation, must have been deposited, at successive intervals, in quiet waters.

III. The rocks superimposed upon the argillaceous slate (vide D, fig. 4, of the plate) appear to have been deposited under conditions no less remarkable than the two preceding divisions. Instead of the uniformly tranquil state of the two preceding periods, the strata bear evidence of having been formed in waters alternately quiet and disturbed. Under these circumstances, were deposited the whole series of this division, which consists of alternate layers of fine-grained sandstone and shale, attaining a thickness of not less than three hundred feet. The layers of sandstone appear to have been formed in a gradually shoaling bay, estuary, or sea, for they are characterized by ripple marks, which, it has been stated by Mr. Conrad, can only be made in shallow waters. These markings are sometimes so surpris-

*It has been penetrated 600 feet in search of salt water

ingly regular and beautiful as to appear artificial, rather than natural, slightly resembling the flutings on some ornamental columns. But in proof of this, reference need only be made to the aquatic vegetables which are found on the surfaces of some of the layers; and which were apparently entombed in the place of their growth.

IV. Resting on the alternations of sandstones and shales, occurs a stratum, (vide E, fig. 4, of the plate) which was formed under conditions widely different from those which prevailed during the deposition of the strata which have been mentioned. It consists of coarse silicious sandstone and conglomerate, both of which frequently pass into each other, according to the variable velocities of the water in which the materials were deposited. That part of the stratum which is conglomerate, is composed principally of quartzose sand and pebbles, the latter of which are variable in size, from a pea to two or three inches in diameter. These materials are partially united, sometimes with iron, and at others, it would appear, merely by adhesion; the pebbles are rounded by attrition, and strongly resemble shingle on the sea-shore. These pebbly materials were, doubtless, deposited by currents of water of unequal velocities, but sufficiently strong to move them onwards, and distribute them over an area of vast extent, leaving the sand in one place, the gravel in another, and the coarse pebbles in another, and so on,—thus producing the various changes which we now observe, and causing the stratum, even in short distances, to pass from sandstone to fine conglomerate, and from the latter to one very coarse in its texture.

This deposite was probably made in the vicinity of dry land, as, near its junction with the strata of the third division, are found the remains of a few terrestrial vegetables.

V. Superincumbent upon the conglomerate, is a series of deposites (marked F, in fig. 4, of the plate) which indicates another important era or change. In the *preceding* period, were strong currents of water, depositing only coarse sand and pebbles; in *this*, the waters were less disturbed, and often tranquil, and so varied, and charged with materials, as to produce layers of sandstone, limestone, shale, coal and iron ore; thus forming a series of strata some hundred feet in thickness, containing rich supplies of the most useful substances for the necessities and comforts of man. During this period must have flourished extensive forests of terrestrial plants, as we find their remains scattered with great profusion through the whole of this series of strata.

VI. The next division (vide G, fig. 4, of the plate) is a rock only a few feet in thickness, but so remarkable in its character, so continuous, and requiring conditions for its formation so widely different from those of any other rocks in the State, that it deserves especial attention. This rock has been called buhr, from its strong resemblance to the buhr-stone of the Paris Basin, and its use in the construction of mill-stones, to which both have been applied. This rock is chiefly composed of silex, but it occasionally contains some calcareous matter. Unlike others of which we have spoken, it seems to have been a deposition from waters containing the materials in chemical solution. It is characterized by the remains of molluscous animals.

VII. This division (indicated by H, fig. 4, of the plate) includes the series of strata above the buhr. It consits of alternations of sandstone, limestone, shale, coal, and iron ore, and may be considered the upper member of the coal formation.

With these preliminary remarks, we proceed to the description of the several divisions, or groups of strata, which we have thus slightly noticed.*

I.

GREAT LIMESTONE DEPOSITE.

Commencing, then, in Adams and Highland counties, the first rock with which we meet is a vast body of fossiliferous limestone, which not only forms the basis of those counties, but stretches west and north to the boundarics of the State, forming the subjacent stratum to a soil of great fertility. The thickness, range, and economical value of this extensive stratum cannot be ascertained until the whole western portion of the State shall have been thorougly explored.

This division presents two varieties: The lower member is gray, bluish gray, and sometimes nearly black; it is sub-crystalline, and, as before observed, abounds with the fossil remains of extinet marine animals. Among them have been observed trilobites, orthoceratites, ammonites, terebratulæ, produeti, encrini, &c. &c. This part of the formation occupies, according to Professor Riddell, but a small part of the area of the State, being principally confined to the southwestern counties.† It has been called by that gentleman "the blue limestone district."

The area of the State, embraced by the upper or more recent member of this limestone has been named "the yellow limestone district" by Professor Riddell, who remarks, in the report to which reference has been made, that "this geological district is perhaps four times greater, in superficial measurement within the State, than the one just described; extending, as it does, from Adams, Highland, Green, and Montgomery counties, northward to Michigan and Lake Erie, and from the shale regions on the Huron and Oleontangy westward, doubtless, beyond the State boundary."

Both these kinds of limestone are of great value for agricultural and architectural purposes, for which they have been quarried and used in various parts of the State. Some of the finer varieties have been polished and used for ornamental work, as jambs, mantel-pieces, &c.‡

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*Arrangements have been made, since writing these preliminary remarks, so that Dr. Hildreth will describe the sixth and seventh divisions indicated on the profile by the letters G and H.

†Professor Riddell's report to the last Legislature.

‡ NOTE. I have referred neither the limestone above described, nor the superincumbent rocks, to any particular class among the fossiliferous strata, though there can be scarcely a doubt as to their geological position and their European equivalents, as may be inferred from their organic remains and lithological characters. On this subject may be quoted the judicious remarks of Prof. W. B. Rodgers, of the Virginia geological survey. He says: "We hold it to be altogether premature, while the geologists of America are yet only on the threshold

II.

ARGILLACEOUS SLATY ROCK, OR SHALE STRATUM.

Progressing eastwardly from the limestone to the western borders of Scioto, Pike, and Ross counties, the limestone sinks beneath the water courses, and is succeeded by a stratum of argillaceous slate, the entire thickness of which is, perhaps, two hundred to three hundred feet. It forms the base of the hills which are capped with sandstone along the western border of the Scioto valley, from Chillicothe to Piketon, and probably nearly to Portsmouth, although the rocks dip slightly in that direction. The color of this stratum is variable, but is generally grayish, or approaching to black; in some places, it contains so much bituminous and carbonaceous matter, that it can be ignited; and, hence, many have inferred that coal may be found within its geographical limits; but, so far as my observations extend, there is little prospect of finding it in sufficient quantities to be valuable. Coal has, however, been observed, according to Mr. I. D. Lapham, in thin seams, an inch or two in width.* This stratum can be examined to advantage on Paint Creek, a few miles east of Bainbridge, and, indeed, through the whole of the valley on that stream to Chillicothe.

As this stratum was more particularly examined by J. W. Foster, Esq., acting assistant on the survey, I may be allowed to quote from an abstract report, some of his valuable observations: "On the silicious limestone is superimposed a thick bed of shale. You have a good view of it at Copperas Mountain, a few miles east of Bainbridge. Its base is washed by Paint Creek, a stream of some thirty yards wide, running into the Scioto. This mountain attains, by estimation, a height of three hundred feet. The shale is exposed two hundred and fifty feet, with sandstone above, say fifty feet. The talus has been washed away by the stream as fast as it fell, so that there is a perpendicular face of nearly 150 feet exposed. The beholder hardly walks beneath these jagged and beetling cliffs with feelings of security. They have yielded, slowly and reluctantly, to the combined assaults of the storm from above and the stream below. In many instances, the torrent, descending from above, has cut out deep gorges in the shale, so that, at a distance, it resembles the ruins of some vast and antiquated castle.

After having gained by a circuitous route, the top of the cliffs, the pedestrian has to clamber up an escarpment of disintegrated shale be-

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of their researches, to endeavor to establish an identity of *names* between our strata and those of Europe. This too frequent error prejudices all the broader and more lofty generalizations of the science. In a spirit of caution, therefore, dictated by the many blunders daily committed in the nomenclature of our rocks, we shall abstain from giving them a class of European names not always, indeed, applicable in the countries where they are employed, and certainly less so in a region of widely different structure, separated by the great interval of the Atlantic. The little that can be said, in a detailed way, upon particular strata, will be descriptive, being convinced that points of nomenclature and classification cannot be ventured upon with profit until there shall have been collected a vast deal more minute information than is now before us."

*Riddell's report to the last Legislature.

fore he attains the summit. The prospect is sufficiently beautiful to repay him for his toil. The cliffs, which from below presented so threatening an aspect, dwindle into insignificance. Here, the ravages of the elements are still more perceptible. They have scooped out large hollows in the cliffs, which are gradually becoming deeper and deeper. From this spot the eye ranges for miles, over a valley of unparalleled fertility, chequered with forests and farms; while far below, the creek sweeps on in its serpentine course, bordered on one side by frowning precipices, and the other by tangled thickets. Few places in Ohio afford a lovelier or more extended prospect.

This shale is very fissile, contains considerable bitumen, and when rubbed exhales a fetid odor. Towards the bottom of this stratum are imbedded masses of fetid carbonate of lime, varying from one to two feet in diameter. These often present a spheroidal appearance outwardly; while within, they exhibit concentric layers, formed around nuclei. These nuclei are amorphous masses, often traversed by *calc spar and sulphate of baryta*. They seem to constitute an interesting variety of *septaria*. No attempt will here be made to explain their spheroidal structure.

The following are some of the principal minerals which occur here: *Fetid carbonate of lime*; *calc spar*, *sulphate of baryta*, *sulphate of alumine* and *potash* (alum) in the form of efflorescence, resembling mould, and investing the shale; also in tuberose masses. It falls down and can be gathered up in considerable quantities. *Sulphuret of iron*, (pyrites) in nodulur masses. *Sulphate of iron*, (copperas) in a yellow efflorescence with the alum."

The three last named minerals are, probably, all which may prove to be of much economical value.

The copperas and alum are produced by the decomposition of the sulphurets of iron by atmospheric agents. The sulphur uniting with the oxygen of the atmosphere, forms sulphuric acid, which, according to circumstances, either combines with the iron to form copperas, or with alumine and potash, to produce alum. These salts, in some places, are produced in so great abundance, that their efflorescence causes considerable areas to appear as if covered with a heavy frost.

Nodular masses of sulphuret of iron are, in some places, so numerous, that they may be used, together with the shales in which they occur and are decomposed, in the manufacture of copperas, which has already been made from these materials for domestic use. It is by no means impossible that beds of gypsum may be found near the junction of this rock with the subjacent limestone, as no other circumstances are necessary for its production, than the decomposition of large quantities of sulphuret of iron in connection with strata of carbonate of lime, so that the sulphuric acid formed from the sulphuret, coming in contact with the latter, produces sulphate of lime, or gypsum.

This enormous mass of argillaceous materials gives rise to numerous chalybeate springs, which are not only valuable for their medicinal properties, but their waters, charged with ferruginous matter, under favorable circumstances, deposit it in the form of bog ore, in sufficient quantities to be used in the manufacture of iron.

This stratum, which at first sight would appear to be of little importance, may prove to be of great value.

III.

Waverley Sandstone Series.

Superimposed upon the stratum above described, occurs a series of alternations of sandstone and shale, the thickness of which has not yet been ascertained, but which will not probably vary far from 250 to 300 feet.

The lower part of this stratum caps the highest elevations near Chillicothe, and it can be studied with great advantage on either side of the Scioto valley, from Chillicothe to Portsmouth. Traveling eastward from this valley, it gradually sinks lower in the hills, till it finally disappears beneath the water courses. It continues some miles above Portsmouth, on the Ohio river; and on the road from Chillicothe to Jackson, disappears beneath the streams about four or five miles from the latter place, so as to form the lowest rock which emerges to the surface in Jackson county, and the one upon which reposes all the strata within its boundaries.

Although the sandstone embraced in the series of strata, the geographical boundaries of which have just been described, may, for the most part, be distinguished by its external appearance; yet, great variations have been observed in its character at different localities, caused by the variable proportions of its component parts, or the occasional absence of one or more of them.

This sandstone is chiefly composed of fine silicious sand; but, in many places, contains variable proportions of argillaceous matter, oxide of iron, and carbonate of lime. Its color is also variable. It is generally white, bluish gray, or tinged with shades of yellow. It is formed of layers, from one inch to five or six feet in thickness, on which are seen ripple marks, produced by the motion of water before the rocks were consolidated. Entombed in these layers are also found the remains of a few marine vegetables, and some zoophytic and molluscous animals: the latter are the most numerous near the junction of this series with the conglomerate which lies above it. In the inferior part of this series, Mr. Foster obtained a few casts of multivalve shells, replaced by sulphuret of zinc.

This series of strata will ultimately be of immense value to the State, as it affords durable and beautiful building materials. It is now wrought, to some extent, for architectural purposes. Some of the finer varieties are of great value for ornamental work; and being nearly as beautiful as some kinds of primitive marbles, may be mistaken for them, at a distance. At those localities where argillaceous matter cements the silicious grains which form the sandstones, they should not be used in situations exposed to the vicissitudes of the weather, as, under such circumstances, they readily exfoliate and fall to pieces, by the combined action of rains and frosts. Some of the

thinner layers afford abundance of beautiful stones, admirably adapted to flagging. Near the junction of this rock with the one which lies above it, whetstones of a very good quality have been obtained.

The fine grained sandstones of this series have been quarried at Portsmouth, Piketon, Waverley, Chillicothe, and other places; and are favorably known in most of the principal towns in the State. Quarries without number may be opened, so that all demands, however great, may be supplied. The limits within which these quarries may be opened, will be determined by subsequent detailed surveys.

As some of the most beautiful stones that have been obtained were quarried at Waverly, we may, for the present, denominate these rocks the *Waverley sandstone series.*

IV.

Conglomerate.

Resting on the series last described, occurs a stratum which is composed of silicious sand and pebbles; it varies in thickness, where it has been observed, from 40 to 80 feet. This, like the preceding, (and it is true of all strata of sedimentary origin,) cannot be identified, at different localities, by external characters alone. In some places it is a fine silicious sandstone, which cannot be distinguished from the stratum which lies above it; in others, it is a conglomerate, chiefly composed of quartzose sand and pebbles, the latter varying in size from a pea to two or three inches in diameter. Sometimes it is strongly cemented by the oxide of iron, and at others the sand and pebbles are but partially united, so that it rapidly crumbles away by the action of frosts and rains. It is of the greatest importance that this rock be carefully studied, and its position, range and extent accurately described, as it forms one of the landmarks, or monuments, by which some of the most interesting and valuable deposites in the State may be traced.

This rock is continuous from the Ohio river, in the eastern part of Scioto county, northward, through the western part of Jackson and Hocking, to Fairfield county. According to Mr. Ewing, of Lancaster, it swells out on the Hockhocking river to a much greater thickness than I have any where observed it.

V.

Lower coal series.

A few miles east of the conglomerate, and above it, in order of superposition, occurs a series of strata composed of sandstone, limestone, shale, coal, and iron ore, the aggregate thickness of which is between 300 and 400 feet. This series occupies a belt of country several miles in width. It commences on the Ohio river, and embraces the eastern part of Scioto county, and the western part of Law-

rence; thence it extends northerly, so as to include a large proportion of Jackson county, the extreme west of Gallia, the west part of Athens, and the east of Hocking county. In this series are three layers of workable coal, three or four layers of limestone, several of iron ore, from one inch to five or six feet in thickness, with numerous strata of sandstone and shale, all of which can be applied to useful purposes. It embraces a group of associated minerals, which, when they shall have been fully explored, will be exhaustless sources of wealth, not only to those in whose immediate vicinity they occur, but to the whole State.

Sandstones.

The lowest and most important stratum of sandstone lies a few feet below the first workable bed of coal, and about 30 feet above the conglomerate. This rock varies from 40 to 70 feet in thickness; it is chiefly composed of silicious sand, but in some places contains quartzose pebbles, and, hence, may be mistaken for the conglomerate. It is sometimes colored and cemented by oxide of iron, and at others, it is nearly white, containing but little ferruginous matter. In some places coal, externally resembling charcoal, is disseminated through the rock. This stratum affords a material suitable for building, and has been quarried for the construction of furnaces. The village of Jackson, Jackson county, is built upon this rock, which can be examined to advantage in that vicinity.

Above this rock occur only two other sandstones which now require description. The first, from 35 to 40 feet in thickness, is situated a little more than 100 feet above the one last-described, from which, in many places, it cannot be distinguished by external characters. This rock, like the preceding, will afford materials for building and the construction of furnaces. It has been quarried in the vicinity of McArthurstown, and used for flag-stones, underpinning, and tomb-stones. For the latter purpose it has been recently introduced.

The principal stratum of sandstone above this is inferior to it in thickness, but approaches so nearly to it in charater, that a separate description of it, at this time, will be unnecessary.

Shales.

The argillaceous shales of this series are of some importance in an economical point of view. Their prevailing colors are yellowish, gray and black. They contain, in some places, so much carbonaceous or bituminous matter as to burn freely when ignited. They generally form the floor and roof of the coal strata, and in such situations often contain beautiful impressions of extinct vegetable remains. In these shales are found embedded most of the iron ores. As they are impermeable to water, while the sandstones suffer it to pass through them, they are generally the water-bearing strata, and hence, wherever they are found, give rise to numerous springs, which are most abundant on the eastern slopes of hills, as the strata dip in an easterly direction.

As in Europe, so in this country, the disintegration of the shales which form the floor of coal deposites, produces fire-clays. Some in this series may be valuable for the manufacture of those articles for which such clays are required. This can only be determined by experiment or chemical analysis.

Clays, or shales, occupying the situation above mentioned, have been obtained at Coal Grove, eight miles above Hanging Rock, on the Ohio river, and used in the manufacture of stoneware. Subsequent examinations may show that this useful material can be obtained in great abundance.

Limestones.

The limestones of this series are interesting, not only as affording a flux for the iron ores of this region, and lime for the various uses to which it is usually applied, but are also of great value for agricultural purposes.

Three layers of limestone have been observed. The first is a gray or grayish white micaceous limestone, variable in thickness and composition at different places. It contains more or less silicious sand, and, in some localities, is very difficult to distinguish from a gray micaceous sandstone. Indeed, I am inclined to believe that this stratum passes into sandstone in which not a trace of lime can be detected. Its geological position is a few feet above the first workable bed of coal. It has been traced from the northern part of Scioto county, through Jackson, to Athens county. It may be seen four miles south of Jackson, on the road to Burlington; it is again exposed in the bed of a small stream, about two miles north of Jackson, on the road to Athens. At Reid's mill, ten miles from the former place, is a sandy limestone, 10 or 12 feet thick, which may belong to this stratum, although the question of its identity is not entirely settled. Here much of it is light colored and sandy, and, unless closely examined, would be passed by as sandstone. It makes good lime for mortar, but, of course, will not bear so much sand as lime made from rocks which contain less silicious matter.

A limestone, identical in appearance and composition with that at the first mentioned places, occurs in Elk township, a mile or two northwest of McArthurstown.

The second stratum of limestone lies about 100 feet above the preceding stratum, and is from 18 inches to 8 feet thick where it has been observed. It is uniformly of a dark color, nearly black, and contains the remains of radiated and molluscous animals of marine origin. The layers vary in thickness from four inches to one foot, and, alternating with them are seams of dark colored shale. This limestone breaks out into oblong blocks, of suitable size for building purposes. This stone will probably bear a polish, and if so, can be used for ornamental purposes, as jambs, chimney-pieces, &c. The organic remains will add greatly to its beauty when polished.*

*Since writing the above, a piece of this dark fossiliferous limestone has been polished. It is nearly or quite equal in beauty to the best Egyptian marbles. If it can be obtained in sufficient quantities, and in blocks sufficiently large, as I think it may, it will be of immense value for ornamental architecture.

This rock has not been as yet discovered south of Jackson court-house, though it probably exists. It may, however, thin out in that direction. But north of Jackson village it has been observed in several places in the county. Loose masses of it are very abundant in some parts of Lick township, where it has been burnt for lime; it exists there also, *in situ*, but no quarries have been opened. In Milton township it also occurs; there it was observed, *in situ*, in the vicinity of Little Raccoon Creek. It is well exposed in Athens, about two miles south of McArthurstown, where it forms the bed of a small stream; here it breaks out in oblong masses, and the fissures are so arranged that the bed of the stream appears as if paved with flags.

The third layer of limestone in this series is from 4 to 12 feet in thickness, and lies one hundred feet or more above the one last described. It is a gray, sub-crystalline, fossiliferous limestone. From this stratum is taken the limestone used in fluxing the iron ores. It is very valuable for this purpose, and also for the manufacture of lime.

There remains to be mentioned another stratum of limestone, the relative position of which has not been determined. It occurs in the south, or southwest part of Jackson county, on the land of John Canter. The whole stratum may be 10 or 12 feet thick. The superior part is white, or nearly so, and is fissured in almost every direction, The lower part is sub-crystalline, and, in some places, beautifully shaded with green and red; and if it can be polished, and obtained in sufficient quantities, will be very valuable in ornamental architecture.* Some beautiful specimens were obtained from a slab which had been quarried to use in the manufacture of millstones. This stratum should be examined with more attention than we have been able to devote to it the present season. It affords a material for the manufacture of lime of an excellent quality, and may also be used as a flux in reducing the iron ores of this vicinity.

Coal.

As it is not our present purpose to attempt a full explanation of the formation of coal, a few remarks only need be made on the subject.

Its vegetable origin is almost universally admitted. By the ablest geologists, it has been considered as resulting from the distribution of large masses of vegetable matter over a previous deposition of sand, gravel, mud, or argillaceous silt, and subsequently covered with the same materials; all of which have been indurated so as to form conglomerates, sandstones, and shales; while the vegetable accumulation, pressure and chemical changes, has been converted into coal.

Evidences are not wanting, to prove that the various coal strata have been formed in this manner. In their associated shales and sandstones, once in the form of sand and mud, we find entombed numerous

* Since writ ng the above, some of these specimens have been polished. We cannot ascertain, with accuracy he value of this rock for ornamental architecture, from the polishing of a few hand-specimens; but it is believed that this stratum may be used for that purpose.

remains of plants, some of which, with their most beautiful and delicate foliage, are as perfectly preserved, as if they had been most carefully prepared to ornament the herbarium of the botanist. Between the laminar divisions of the coal itself, the vegetable structure can often be distinctly seen. In many situations are found numerous silicified stems, or trunks of trees, belonging to those primeval forests from which our fossil fuel has probably been accumulated. Some of these stems, or trunks of ancient trees, varying in size from a few inches to two feet in diameter, have been so flattened by the pressure of the superincumbent sandstones, shales, &c., as to make the greater diameter nearly four feet. The silicified remains of these ancient forests are, in some situations, so numerous as to be truly astonishing. One of the most remarkable localities is on Shade river, about six miles from Athens. Here they are so abundant, that many teams may be loaded with segments of fossil trees, which have been left exposed by the degradation of the adjacent sandstones, in which they were formerly entombed. It is remarkable, that although these fossil plants resemble in structure those flourishing at the present day in tropical climates; yet, none of them are now known to exist on the surface of our planet.

Dr. Buckland, in speaking of the splendid exhibitions of fossil plants in the coal mines of Bohemia, says: "The most elaborate imitations of living foliage upon the painted ceilings of Italian palaces, bear no comparison with the beauteous profusion of extinct vegetable forms with which the galleries of these instructive coal mines are overhung. The roof is covered as with a canopy of gorgeous tapestry, enriched with festoons of most graceful foliage, flung in wild, irregular profusion overy portion of its surface. The effect is heightened by the contrast of the coal black color of these vegetables with the light groundwork of the rock to which they are attached. The spectator feels himself transported, as if by enchantment, into the forests of another world; he beholds trees, of forms and characters now unknown upon the surface of the earth, presented to his senses almost in the beauty and vigor of their primeval life; their scaly stems, and bending branches, with their delicate apparatus of foliage, are all spread forth before him—little impaired by the lapse of countless ages, and bearing faithful records of extinct systems of vegetation, which began and terminated in times of which these relics are the infallible historians.

"Such are the grand natural herbarea wherein these most ancient remains of the vegetable kingdom are preserved, in a state of integrity little short of their living perfection under conditions of our planet which exist no more."*

Coal of the Hocking Valley.

The coal of this valley, and its associated minerals, iron and salt, will, at no distant day, be extensive and lucrative articles of com-

* Bridgewater Treatise, vol. 1, page 344.

merce; and when our noble system of internal improvements shall have been completed, will find their way into every county in the interior of the State, not only increasing her revenue from the canals, but adding permanently to the general interests of her citizens.

Before speaking particularly of this interesting valley, acknowledgment should be made for the valuable information received from Hon. Thomas Ewing, who, by his accurate knowledge of local geology, facilitated my investigations by spending some days with me in the examination of the most important localities.

In this series, so far as my observations now extend, are three workable seams of good bituminous coal, successively cropping out at the surface on the Hockhocking river, between the mouth of Sunday creek and a point four to seven miles west of Nelsonville. The course of the river, here, is nearly southeast. These layers of coal, separated from each other by layers of sandstone, limestone, shale, &c., gradually rise in the hills, in ascending the river, but in an opposite direction, sink in them, till they finally disappear beneath the bed of the Hockhocking; occupying a distance along the river of about ten or fifteen miles.

Both north and south of this valley, numerous openings will be made in these beds of coal whenever a sufficient demand shall be created by the opening of the Hocking Canal, now in progress of construction. According to information from Dr. Hildreth, the range of rocks in which these beds are situated, is continued northward through the counties of Perry, part of Licking, Morgan, and Muskingum; thence they extend, nearly in the same direction, to the Falls of the Cuyahoga. In a southerly direction, they embrace, as remarked in a general description of the strata of this series, portions of the counties of Athens, Hocking, Jackson, Gallia, Lawrence, and Scioto.

In descending the Hockhocking river from Logan, the first workable bed of coal was observed near a Mr. Brit's, about four miles west of Nelsonville. The coal here is of good quality. No opportunity occurred, to ascertain its entire thickness from personal examination; but I was informed, by individuals on whom the greatest reliance can be placed, that its average thickness may be safely estimated at four feet.

The stratum of coal next in geological position above the one just described, is well disclosed at Nelsonville, about seventy or eighty feet above the bed of the Hockhocking at that place.

As the most extensive openings have been made in the neighborhood of Nelsonville, this coal is generally denominated "Nelsonville coal." This name has been adopted by Dr. Hildreth, in some manuscript notes, with the examination of which he has kindly favored me.

This coal is from six and a half to nine feet thick, separated by a thin layer of shale from a stratum of sandstone, which will, in most places, form a permanent roof to these mines when they shall have been opened. The coal is of excellent quality. It readily splits, parallel to the plane of its stratification, into thin laminæ, on which the traces of vegetable fibre can often be distinctly seen. On account of its

thickness, extent, superior quality, permanent roof, &c., this layer of coal is one of the most valuable in the State; at least, the most so in the Hocking Valley; and will, at no distant period, exert an important influence upon the interior counties, as well as upon the vicinity in which it is located. Upon either side of the Hockhocking river, in descending from Nelsonville, openings can be made in this stratum, for four or five miles.

Above the Nelsonville coal, and below the buhr-stone, occurs at least one other bed which is workable. Coal occupying this position has been worked, in several places, in the vicinity of the salt wells, on the Hockhocking, and used in the evaporation of brine. The question as to the geological position of these openings, must be determined by subsequent examinations.

Coal of Jackson, Scioto and Lawrence Counties.

In these counties are also three beds of workable coal, which are probably equivalent to those of the Hocking valley. It will be recollected that all these are embraced in the series of strata, between the conglomerate and buhr. The western outcrop of the lowest seam may be indicated by a line drawn from the Ohio river, near the Franklin furnance, in Scioto county, northward, to Richland, in Jackson county; but, as this outcrop is irregular, coal may be found West of this line on *high elevations*, and be deficient in *those* East of it. Like the coal, which has heretofore been described, it is made up of laminae, containing distinct traces of vegetable fibre, often so thin, that a great number can be counted within the space of a few inches. This coal burns with a brilliant yellowish flame, and being free from sulphuret of iron, is very highly esteemed for fuel, and smith's purposes. In some places it appears to pass into cannel coal. On account of its purity, it may be used in the smelting of iron. It is preferred at the furnaces, by those acquainted with its character, to either of the beds which lie above it in this series; and must, at some day, be of great value to this part of the State, not only to the furnaces, but to those places on the Scioto valley, which must, ultimately, be supplied with fossil fuel from this stratum. Numerous openings have already been made in this bed. It has been used in Jackson, Athens, and Scioto counties. Four or five miles West of Jackson, this coal has been dug, and drawn by teams to Chillicothe, where it costs, on delivery, about 16 cents per bushel. It has been taken from banks, owned by Messrs. Chandler, Milligan, McKinnis, Howe, Ward, Landrum, and others. We have no data from which to estimate the quantity of coal annually taken to market from these mines; but its amount, which is increasing, must already be many thousand bushels.

Above this bed, occur, at least, two others which are workable. In Jackson county, they have not been wrought except for smiths' purposes, and in a few instances for fuel, by those living in their immediate neighborhood. The outcropping edges of these layers of coal, are found a few miles East of that which forms the western boundaries

of the coal deposits of the State. One or both of these beds will be found in the townships of Clinton, Milton, Bloomfield, Madison, Jefferson, and Franklin, in Jackson county; thence, they extend, southerly, to the Ohio river, through the easterly portion of Scioto county, and the western part of Lawrence, where they have been used at some of the furnaces.

Besides these three beds, there are some thinner ones, which, perhaps, may be wrought in a few localities.

We have thus given a brief description of the coal of this group of strata, the aggregate thickness of which is variable, but it may be safely estimated from 10 to 12 feet, though in some places it may be 17 feet.

These three layers of coal, with the strata in which they are embraced, are so abraded, and their debris removed, that they occupy only a small portion of the area, included between their western outcrop, and the point at which they disappear beneath the beds of the streams.

The whole amount of coal between these points, from the Ohio river, north, to the Hocking valley, may be safely estimated as sufficient to form an entire stratum, 50 miles in length, 5 miles in width, and 9 feet in thickness. This amount of coal will yield about 9,000,000 of tons per square mile. This estimate includes but a very small part of the coal, which can be obtained from the beds heretofore described; for, after disappearing beneath the water courses, they, doubtless, continue, westward, toward the Ohio river, sinking deeper and deeper beneath the surface, so that they can be reached only by shafts near the Ohio, at the depth of some hundred feet. The method of obtaining coal, by sinking shafts, has not yet been practiced in this country to any considerable extent; but will, ultimately, be in Ohio, when the consumption of fossil coal shall have created a sufficient demand for the article. Shafts have been sunk, with success, under the direction of practical geologists, in Great Britain, to the depth of 1200 to 1500 feet. Coal must, undoubtedly, be obtained in this way in our own country, at no very remote period.

Iron Ores.

In describing the geographical boundaries of this series of strata, the limits of the iron ore region were defined; the first bed of ore occurs not many feet above the conglomerate, and is succeeded by others, at greater or less intervals, to the buhr. These several layers or seams of ore, vary in thickness from an inch to 5 or 6 feet, and are, generally, associated with, and embraced in, beds of shale, with which they were contemporaneously formed. Their origin appears to have been from a semi-fluid mass, composed of ferruginous, calcareous, silicious and argillaceous matter, together with small portions of zinc, lead, and some other substances, but not so dense as to prevent freedom of motion between the particles of which it was composed. By the superior attraction of particles of the same kind for each other, the ferruginous particles arranged themselves around numerous cen-

tres, or nuclei, and thus formed nodular masses, composed of concentric layers, arranged over each other, like the coats of an onion. These nodules, in many instances, are so abundant, and have been subjected to so much pressure from the superincumbent layers, as to leave the interstices between them very small, and give to the beds, at first sight, the appearance of solid, unbroken layers of iron ore. By this pressure, these nodules, when not very numerous, are merely flattened; but when very abundant, the weight, from above, seems to have moved them laterally against each other, with so much force, as to destroy their original form, and curve, in various directions, the concentric coats of which they are formed.

Some of the iron ores appear not to have been formed in this manner; but a structure, similar to the one just described, can generally be discovered by close examination.

It is not intended, in this report, to discuss, fully, either the origin of the ores, or the varieties which have been observed, as, for very obvious reasons, such discussions should be deferred till they shall have been subjected to chemical analysis.

Iron Ores of Lawrence and Scioto Counties.

"The several deposits of iron ore in these counties, extending to six or more distinct beds, lie at an inclination of about 30 feet to the mile, dipping to the east southeast; and are seen, as we travel easterly, cropping out at successive, but irregular intervals, on the surface of the highest hills, at a few miles back from the river, and gradually sink deeper in the earth, are finally lost at the base of the hills, disappearing beneath the beds of the streams."*

The numerous layers of sandstone, limestone, coal, shale, &c., with which these ores are interstratified, have been worn down and cut through by degrading agents, so as to form hills, valleys, and ravines, and give to this region a wild and rugged aspect. But the inclination of the strata, which have been thus interrupted, is so slight, and the valleys, generally, so narrow, that they can be traced, without much difficulty, from hill to hill. This peculiarity of surface, although it renders the country less valuable for agricultural purposes, has disclosed, and made easy of access, its vast mineral resources.

These beds of ore, situated as they are, in a finely wooded country, being easy of access, and associated with all the materials necessary for their reduction, cannot fail to be immense sources of wealth.

The first furnace for the smelting of these ores, was erected by the Hon. James Rogers, in Lawrence county, in the year 1826. Subsequently, eight other furnaces have been erected in Lawrence county, and five in Scioto.

The names of these furnaces in Scioto are, Franklin, Junior, Scioto, Bloom and Clinton; in Lawrence county, Union, Pine Grove, Etna, Vesuvius, Hecla, Lawrence, Mount Vernon and Lagrange. Since the

* Dr. Hildreth's report to the Legislature, 1336-37.

erection of the first furnace, in the year 1826, their number has been steadily increasing. Lagrange was erected in 1836, and subsequently several locations for furnaces have been made, some of which, on account of the state of the money market, have not been erected.

As only two or three of these furnaces have been visited, and none of the ores analyzed, a detailed account of our iron ores, and the best methods of working them, must be omitted till the detailed economical geology of this part of the State shall have been completed. A few facts, however, of a general nature, may not be uninteresting on this subject; and in communicating them, we cheerfully acknowledge the kindness and hospitality with which we were uniformly received by those gentlemen engaged in the manufacture of iron on whom we had occasion to call. Great interest was manifested in the objects of the survey, and every facility was afforded us in the prosecution of our investigations. Our particular acknowledgments are due to Hon. James Rodgers, of Hanging Rock, Gen. Kendal, of Portsmouth, Rev. Dan Young, of Franklin Furnace, Mr. Murfine, of Scioto Furnace, and Messrs. Salters & McCollum, of Clinton Furnace.

Location and construction of Furnaces.

Great care and experience are necessary in selecting an eligible site for a furnace. The principal objects to be kept in view are, a sufficient supply of ores, fluxes and fuel, so near each other, and to the furnace, that they can be delivered with little expense; and so located as to afford facilities for transporting the iron to market without great expenditure. About 4,000 to 5,000 acres of well wooded land are considered, by proper attention to the second growth, sufficient to supply a furnace with charcoal for any period.

As most of the ores, now considered workable at the furnaces, are, in geological position, above the first workable bed of coal, the location should be east of it, in order to be the most favorably situated as regards the proximity of the materials to be used in the manufacture of iron.*

In these counties, the common high furnaces are the only ones which are used. They are nearly similar in construction, but vary a little in breadth and height, the dimensions of the hearth, height of the tuyere, and pitch, breadth, and perpendicular height of the boshes. The following, as the best dimensions for the construction of a furnace, were given to me by Mr. Salters, of Clinton Furnace:

* There is one bed of ore below this coal, which, as it is continuous over considerable areas, and in some localities of great thickness, requires particular notice. It has been traced continuously from the Ohio river northwardly, through the eastern portion of Scioto county, to the valley of the Hockhocking river, near Logan, a distance of more than sixty miles, varying in thickness, where it has been examined, from one to five feet. This ore generally contains silicious sand, and, in most localities, quartzose pebbles. It has been generally rejected at the furnaces, on account of the difficulty of reducing it; but I am inclined to believe that some of the better varieties may be used, by giving a different pitch to the boshes, and properly regulating the flux, &c. If future experiments shall show that this iron ore can be profitably smelted, the vast area of land on which it is found will be greatly increased in value.

"*Dimensions of Hearth, &c.*

Square at bottom of hearth·························22 inches
Square at the top···24 inches
Height of hearth··5 feet
Heigh of tuyere above the bottom stône of hearth·······17 to 19 inches
Height of the tymp above the bottom stone of the hearth· ···15 inches

The inclination or "batter" of the boshes should be 10 inches to the foot; and the distance across the top, from 9 feet to 9 feet 6 inches. The height of the furnace, from the bottom stone of the hearth to the mouth, or trundle-head, from 30 to 35 feet."

The above dimensions include only those which are most essential. The furnaces are almost entirely constructed from the sandstones which are associated with the iron ores. The materials are quarried out in large heavy blocks, and laid up without either mortar or cement. The main building, or "stack," if properly constructed, will last many years; but the in-walls and hearth-stones, although constructed in the best manner, and with the best materials, will, in a short time, be destroyed by the effects of heat.

Of working and smelting Ores.

Instead of drifting or mining, as is done in working the coal beds associated with the ores, they are obtained by a process called "stripping," which consists in entirely removing the incumbent materials. Situations for this purpose are found near the outcropping edges of the layers. It has been estimated that earth, stones, &c., can be profitably removed at the rate of one foot to every inch of good iron ore, making 12 feet "stripping" to the foot. Seams of iron ore, not to exceed 4 to 6 inches in thickness, are frequently used. In working the beds around the sides of hills, the strippings gradually become deeper and deeper, till the spot is finally abandoned for another where less labor is necessary to obtain the ores.

In process of time, the "strippings" will become so deep, that it will be necessary to "drift" for the ores. This process, it is believed, will be attended with less expense than the present one, especially when the beds are of any considerable thickness, and are situated near the furnaces, as in such cases the item for transportation of ore, which is a heavy one in the expenditures of a furnace, would be greatly reduced. To obtain the thickest and most valuable beds, where they have disappeared beneath the water courses, shafts can be sunk through the rocks which overlie them; but such operations should be conducted only by men who have experience in mining operations. Before smelting, the ores from various beds are mixed and roasted. They are then placed upon a bench or platform of iron bars, separated from each other by a space of about one inch, and pounded with iron hammers till they fall through at the bottom. They are then thrown into the furnace, with one-tenth their weight of limestone, to be smelted. The ores yield from 33 to 37 per cent. of pig iron.

The following statement, furnished me by Mr. McCollum, from the books of Clinton Furnace, will be interesting, as an exhibit of the relative quantities of stock used, and the iron made, in a blast of 204 days:

"CLINTON FURNACE,
Scioto county, Ohio, 1836.

Relative quantities of stock used, and iron made, in one blast of 204 days.

Charcoal	307,876 bushels
Stone-coal	30,277 bushels
Limestone	260 tons
Iron ore	2,546 tons
Pigs made	896 tons
Average quantity per day	4 t. 7 cwt. 3 qrs. 10 lbs.

Average stock used per day.

Charcoal	1,509 bushels
Bituminous coal	148 bushels
Iron ore	12 t. 9 cwt. 2 qrs. 12 lbs.
Limestone	1 7 1 22

Average stock to make each ton of iron.

Charcoal	343¾ bushels
Ore	2 t. 16 cwt. 3 qrs. 9 lbs.
Bituminous coal	33¾ bushels
Limestone	6 cwt. 1 qr. 25 lbs.

Ore used in the blast, 28,511,040 pounds; iron made, 10,161,280 pounds; which is equal to a yield of 35.64 per cent."

Mr. Murfine informs me that the ores at the Scioto Furnace yield about 37 per cent., and that the average quantity of iron made per day, while in blast, is about 4¾ tons.

In forming an estimate of the value and importance of the iron business in these two counties, (Scioto and Lawrence,) I may be allowed to quote from an able paper written by Dr. Hildreth in 1836:

"The furnaces make an average amount of 1,000 tons of pig iron per year, some of them making more than this quantity, and others less. During the past season pig iron has been worth forty dollars per ton at the landing, where the metal is delivered to purchasers. Producing an amount of iron worth five hundred and twenty thousand dollars per year, one-half of this quantity is made into castings and stoves, directly as the metal flows from the furnace, worth sixty dollars per ton, which will add one hundred and thirty thousand dollars more to the gross amount: making the sum of $650,000 as the product of these thirteen furnaces. The number of furnaces is steadily on the increase, several new ones going into operation the present year; in addition to which, the bar-iron manufactured at the forges will swell the present amount to a considerably larger sum. Each

furnace employs, on an average, about one hundred men, and fifty yoke of oxen, all which are fed from produce grown in these counties, and those lying higher up the country on the Ohio and Muskingum rivers, affording an extensive home market for large quantities of corn, oats, flour and bacon, and already nearly as important as that of Cincinnati to many of the river counties.

"The furnaces on the Kentucky side of the Ohio river, in the iron ore region, are quite as numerous as those in this State, and assist in giving permanence and value to this new market. When the number of furnaces is quadrupled, as they in a short time must be, from the regularly increased demand for iron in railroads, steam engines, &c., the value of the iron manufacture will be swelled to several millions, and the market for the productions of the soil be proportionally increased. So true it is, that agriculture and manufactures are twin sisters, and go hand in hand, affording mutual benefit and assistance to each other."

Iron Ores of Jackson County, &c.

It has been the prevailing opinion, that the valuable deposits of iron ore from which the furnaces in Scioto and Lawrence have been supplied, were confined to those counties; and in consequence, those in Jackson have been entirely neglected until the present season. The distance of this county from the Ohio river and the canal, has, without doubt, hitherto prevented explorations, as furnaces situated so far from water communication, could not successfully compete with those having greater facilities for transportation. A company, however, has been formed, and a site selected for a furnace, in the southwest part of this county, in Hamilton township, by gentlemen practically acquainted with the manufacture of iron. Under their direction, a furnace, called the "Jackson Furnace," is now in the progress of construction. It is thirteen miles from the Ohio river, but is considered one of the most eligible locations, on account of the proximity of the ores, limestones, &c., to the furnace, and to each other.

Much labor has been spent in tracing these iron ore deposits. They occupy the whole eastern portion of the county, being merely a continuation of those in Lawrence and Scioto. The western outcrop of the most valuable beds, may be indicated by a line drawn from Hamilton, a little east of north, to the northern boundary of the county. In some situations, where the hills are sufficiently high, good beds of ore may be found west of this line; but furnaces should be located east of it, in order to be the most favorably situated in reference to the proximity of the materials necessary in the manufacture of iron. Though none of the beds have been extensively opened, yet, from the quality of the ores, and the abundance in which they are found on the surface, by the wasting away of the rocks in which they were embraced, they are probably equal, in every respect, to those of Lawrence and Scioto counties.

This iron ore region has not been minutely explored farther north than the south line of Athens county; but subsequent examinations

will doubtless show that tt extends onward to the Hocking Valley, from partial examinations in which, it is probable that ores of good quality may be obtained in sufficient quantities to justify the erection of furnaces.

In closing this hasty sketch of the iron ore and coal deposits of this series of strata, it may be proper to glance at the future importance of the manufacture of iron in this part of the State.

The prosperity of this branch of industry is always mainly dependant upon the abundance of the raw materials which must be used, and the small amount of labor and expense with which they can be obtained. Here, we have all the facilities necessary to success. The fuel, fluxes, and ores are so abundant, and contiguous to each other, and can be obtained with so little expense, that the manufacture of iron, under judicious regulations, cannot fail to be eminently successful.

At a very low calculation of the amount of good iron ore in the region which has this season been explored, it is equal to a solid, unbroken stratum, sixty miles in length, six miles in width, and three feet in thickness. A square mile of this layer—being equivalent, in round numbers, to 3,000,000 cubic yards—when smelted, will yield as many tons of pig iron. This number, multiplied by the number of square miles contained in the stratum, will give 1,080,000,000 tons; which, from these counties alone, will yield annually, for 2,700 years, 400,000 tons of iron—more than equal to the greatest amount made in England previous to the year 1829.

From this estimate, which it is believed is much too low, it appears that the iron ores of this portion of the State are not only sufficient to supply all domestic demands for ages, but to form an important article of commerce with other States.

There can be no doubt that the manufacture of iron will continue to increase for many years; and, with the exception of agriculture, it may become the most important branch of industry to the citizens of the State. To be convinced of this, reference need only be made to the constantly increasing demand for iron, the facilities for its manufacture, and the amount annually imported into this country.*

In reflecting upon the prospective importance of the iron business to Ohio, a question naturally suggests itself, as to the necessary supply of fuel; for if dependence be placed entirely upon charcoal for smelting operations, this branch of industry must be comparatively limited. And, as the forests in this ferriferous region will be sufficient to reduce only a small part of the ores, our attention, on a subject of so much importance, should not only be directed to economy in the use of fuel, and to the preservation of our forests, but to the means of obtaining a sufficient supply from some other source.

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* "The value of iron and steel manufactures imported into this country previous to the 30th of January, 1836, was $7,717,910. The year previous, the import was less than $5,000,000.

"Mr. Cambreleng's Report shows an increase in the importation of bar iron for the seven years previous to 1835, of 77½ per cent. over the former seven years, or from 1821 to 1828"—Prof. JAS. HALL, New York Geological Report, 1836—7.

Perhaps no fears need be entertained on this head, as the introduction of the hot blast, and the probability that some beds of bituminous coal will be soon brought into use for the smelting of iron ores, render it nearly certain that this branch of industry will never receive a check from an insufficient supply of fuel.

Ores of zinc and lead.

In the examination of the strata of which a brief description has been given, small quantities of lead and zinc have been seen, but not in sufficient abundance to be valuable. Mr. Foster, however, discovered a seam, or thin bed, containing a large proportion of sulphuret of zinc, which, it is *possible*, may be profitably wrought. This will be determined by subsequent examinations and chemical analysis. Sulphuret of zinc is sometimes found as the nucleus in nodular iron ores.

There are rumors, in the southern portion of the State, in reference to lead mines, but as yet no veins have been discovered; small quantities of lead have, however, been found in loose masses on the surface. A small piece of this description was recently sent to me from Jefferson township, Jackson county.

Lead must exist in small quantities in either the iron ores or limestones of Lawrence and Scioto counties, as several pounds are, not unfrequently, taken from the crevices in a furnace hearth at the close of a blast*

Notwithstanding these indications, it is believed that there is but little prospect of finding lead in sufficient quantities to be valuable, as rich veins of lead rarely, if ever, penetrate the coal measures; while they are often fouud in the subjacent limestone.

Geological position of the muriatiferous rocks and salines.

As Dr. Hildreth has given the history of the various salines of the State, my remarks upon this subject will be principally confined to pointing out the geological position of those which have come under my observation.

The determination of the geological position of the strata from which the brine issues, is a matter of high scientific and practical interest, as upon this will depend our success in tracing the muriatiferous rocks, and pointing out situations where explorations for salt water may be made with some degree of certainty.

Water, impregnated with muriate of soda, has been found in all the rocks, from the superior part of the conglomerate down to the great limestone deposite, which is indicated on the profile as underlying the the whole eastern portion of the State. By reference to the plate, it will be seen that these limits embrace the conglomerate, Waverly sandstone series, and the great mass of argillaceous slate or shale, that is immediately superimposed upon the limestone.†

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*This information was communicated by Mr. Smith, of the Jackson Furnace.

†Note. This limestone contains weak brine springs in a few locations; and it is probable that the rocks above the conglomerate, in some places, contain the saline matter necessary to produce them.

In the argillaceous shale (vide C, fig. 4, of the plate) salt water has been obtained in several places by boring; but it was so deficient in quantity and strength that it could not be used profitably in the manufacture of salt. One of these wells was bored in the valley of Paint Creek, about three or four miles west of Chillicothe. Its position is indicated on the profile, to which reference has been made, by the perpendicular line *a a*.

Brine has been obtained in the Waverley sandstone series, by sinking through the conglomerate at the licks in Jackson county, and good water obtained, but not in quantity sufficient to be profitably used in competition with the Kenawha salt wells, in Virginia. The salines at Jackson, early attracted the attention of the western pioneers; and from them, alone, was obtained most of the salt used in the early settlement of the State. They were finally abandoned, in consequence of much stronger brine having been obtained in Virginia. These wells, with the exception of those called "mud wells," were commenced in the superior part of the conglomerate, which, on this account, was denominated the "salt rock."* They varied in depth from 10 to 450 feet, with no sensible improvement in the strength of the brine, except in the deepest, which was bored at the expense of the State; and in this, no difference was observed in the saturation of the water, till the strata had been penetrated 350 feet, when it continued to improve, till the work ceased. Mr. George Crookham, by whom the information in regard to these wells was communicated, says he thinks the brine, at the depth of 350 feet, was equal in strength to that used on the Kenawha, but that the quantity was comparatively small. This well, which penetrates the Waverley sandstone series, is indicated on the profile by the perpendicular line *b b*.

The valuable salt wells on the Hockhocking river, five miles west from Athens, were commenced in the superior part of the series, indicated on the profile by the letter F. The water from these wells is said to be equal, in every respect, to the best wells on the Kenawha, yielding about ten per cent. of salt. These wells are about 430 feet in depth; a distance sufficient to penetrate the conglomerate, and, perhaps, to reach the Waverley sandstone.

All those wells which were commenced in strata in a geological position *below* those before mentioned on the Hockhocking river, are deficient in the strength of the brine. The principal cause of this may be found in the fact, that they were situated so far west, as to be too near the outcropping edges of the muriatiferous strata; in consequence of which, the water, before rising to the surface, could not percolate a sufficient distance through the strata to become thoroughly impregnated with saline matter.

The wells at Jackson, in addition to the disadvantage of having been commenced *too low* in the series, were situated on a stream, the

* The "mud wells" were dug to the depth of 24 to 30 feet, in clay, sand and gravel, which occupy a basin-shaped cavity in the superior part of the "salt rock," at Jackson.—The brine, without doubt, was produced by the percolation of water through the rock into this reservoir.

waters of which run in a direction opposite to the dip, through deep valleys and ravines, which so interrupt the continuity of the strata, that a considerable portion of the saline matter finds its way into the water courses, and flows off in a westerly direction.

From the facts which have been stated, it may be inferred that locations for salt wells, to be the most judicious, should be higher in the series than the conglomerate, and on those streams which flow across the country in an easterly direction, or nearly in the line of dip. And as some of the strongest brine has, probably, been obtained in the conglomerate, the wells should be bored so deep as to penetrate that stratum.

There are other circumstances which influence the quantity and strength of brine, besides those which have been stated. Among these may be mentioned fissures and undulations in the strata, and the relative amount of saline matter in the muriatiferous rocks at different localities; in consequence of which, some uncertainty will always attend boring in search of salt water.

FOSSIL BONES.

As before observed, some of the salt wells in Jackson county were dug in a deposit of clay, sand and gravel, occupying a basin-shaped cavity in the superior part of the conglomerate. In nearly all these wells were found fossil bones, consisting of jaws, teeth, tusks, vertebræ, ribs, &c , which, from the descriptions given by Mr. Crookham, belong to extinct species of animals. From his descriptions, remains of the megatherium, and of the fossil elephant, were among the number. A more detailed description of the bones from these wells, will be communicated at another time.

Mammoth, or Fossil Elephant.

About two years ago, some bones, so large as to attract the attention of the inhabitants, became exposed in the bank of one of the branches of Salt creek, in the northwest part of Jackson county. They were dug out by individuals in the vicinity, from whom we obtained a tooth, a part of the lower jaw, and some ribs.

In the examinations at this place, during the past season, it was concluded to make further explorations, not only wiih the hope of finding other bones, but with a view of ascertaining the situation, and the nature of the materials, in which they were found. The explorations were successful. There were found some mutilated and decayed fragments of the skull, two grinders, two patellæ, seven or eight ribs, as many vertebræ, and a tusk. Most of these are nearly perfect, except the bones of the head. The tusk, though it retained its natural shape as it lay in the ground, yet, being very frail, it was necessary to saw it into four pieces, in order to remove it.

The following are the dimensions of the tusk, taken before it was removed from the place in which it was found:

Length on the outer curve		10	feet	9	inches.
"	" inner curve	8	"	9	"
Circumference	at base	1	"	9	"
"	2 feet from base	1	"	10	"
"	4 " "	1	"	11	"
"	7½ " "	1	"	7½	"

This tusk weighed, when taken from the earth, 180 lbs. The weigh of the largest tooth is 8¼ lbs.

These bones were dug from the bank of a creek, near the water, where they were found under a superincumbent mass of stratified materials 15 to 18 feet in thickness. The section, (fig. 3, of the plate,) carefully taken on the ground, will give a correct idea of the arrangement of the materials, and the relative position in which these interesting fossils were found.

No. 1 is a yellowish clay, or loam, which now forms the surface of a swamp about one mile in length, and one-fourth to half a mile in breadth; it is covered with large forest trees, many of which, from their size, must have been growing some centuries—5½ feet.

No. 2. This layer is a yellowish sandy clay—7½ feet.

No. 3 is an irregular layer of ferruginous sand, tinged with shades of red and yellow, and partially cemented with iron—4 to 8 inches.

No. 4 is a chocolate-colored clay or mud, the inferior part of which contains the remains of a few gramineous plants, very much decayed—2 feet.

No. 5. Sandy clay, colored, like No. 4, but a little lighter—1½ foot.

No. 6 is the stratum containing the bones. It consists, judging from external characters, of sand and clay, containing a large proportion of animal and vegetable matter—1 to1½ foot.*

These bones, from their position, had evidently been subjected to some violence before they were covered with the stratified deposites which have been described.

The jaw and grinders, with the other bones which we have thus slightly noticed, evidently belong to an extinct species of the elephant, now found in a fossil state. As the teeth differ from any which are figured and described in the books to which I have access at the present time, it is possible they may belong to an undescribed species.

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*All these layers, with the exception of the ferruginous sand, contain so much carbonate of lime as to effervesce briskly with acids. They will be valuable as manures, on light, sandy soils, deficient in carbonate of lime.

In bringing to a close this abstract account of my labors during the past season, it may be stated that perhaps no part of the world is more productive than will be the entire portion of the State which has this season been partially explored. The *western* portion, embracing the vallies of Scioto and Paint, is almost unequalled in fertility of soil; while the *eastern*, although not so fruitful, contains, beneath the surface, exhaustless stores of mineral wealth. Those counties which have hitherto been considered of so little value for agricultural purposes, are destined to become some of the most wealthy and densely populated in the State.

I cannot close this communication without acknowledging the valuable assistance which has been rendered me by J. W. Foster, Esq., Acting Assistant on the survey. He fully participated in all the labors of the season, and deserves my warmest thanks for the prompt and efficient manner in which he discharged all his duties.

I have the honor to be ,with great respect,

Your obedient servant,

C. BRIGGS, Jr.,

Fourth Assistant Geologist of Ohio.

COLUMBUS, *January* 1, 1838.

REPORT

OF

MR. WHITTLESEY,

TOPOGRAPHER OF THE GEOLOGICAL SURVEY OF OHIO.

No. 5.

To W. W. Mather, Esq.,
Principal Geologist of Ohio.

By your instructions of the 23d of June last, I am directed to proceed to the region, included between the Scioto and Hockhocking rivers, and construct skeleton maps, of the townships and counties within that district, for the use of the geologists in the field. These maps were to exhibit, "as far as practicable, the lots as originally laid out, and subsequently divided, the courses and meanderings of the streams, and the topographical details of the country adjacent." As this branch of the survey was instituted more particularly with a view to enable the scientific explorer, to locate his discoveries with the greatest possible accuracy, I have executed the instructions "as far as practicable."

From the best authorities within my knowledge, I have constructed plans of townships, for the counties of Jackson, Lawrence, Gallia and Hocking, and for those parts of Scioto, Pike and Ross, lying east of the Scioto river. They are upon a scale of two inches per mile, accompanied by county maps (with the exception of Gallia county,) on a lineal scale of one-half their size. The streams, down to the minutest branches, the civil and mathematical divisions of the territory, the general course of traveled roads, with mills, furnaces and villages, are represented upon them.

The subsequent divisions of the soil, according to present ownerships, are seldom to be found, and are undergoing constant changes. The exact meanderings of the streams can only be obtained by a survey; and more pressing duties have prevented this, with the exception of the south fork of Salt Creek, and part of the Middle fork. In a country so uneven as the river counties, where several independent hills or bluffs occupy each square mile, without any approach to ranges, it is impracticable to locate every irregularity of surface, without a *trigonometrical survey*, or to represent it when located, without greatly enlarging the scale. Moreover, the streams are a true index to the configuration of the country; each water course representing a valley between high lands; and few, or none, however small, escape notice.

Original Surveys.

Most of my information is derived from the land offices of the General Government, where all lands sold by the United States, are represented in townships of six miles square, subdivided into parcels of one mile square, containing 640 acres. Where the lines of the original surveys cross a stream over seven links in width, the distance from the last corner, the course and breadth are noted.

Most of the country delineated this season, is within a Congress land district; and those parts lying in the "Ohio Company's Purchase," are represented in the same way; the original allotment having been made by order of Congress, and upon the general principles of the public surveys. The *entire territory* of Ohio, is surveyed according to the same general system, excepting the "Virginia Military Reservation," the "Western Reserve," "Military Bounty Lands," and some small unsurveyed Indian Reserves.* Streams considered navigable for batteaux, were surveyed upon both shores, and may be traced with accuracy; but for those of a lesser size, the course between section lines is imaginary.

Highways.

Roads are designated upon the skeleton maps, but only in a general manner. Owing to material variations in the magnetic needle, both by lapse of time, and change of place, the recorded plats of county and State roads run at various times, without system, and without reference to the true meridian, cannot be connected in a geometrical manner with the section lines of the public lands; the latter coinciding with the parallels of latitude and longitude.

The public highways have been established, by ascertaining the names of individuals resident upon the route, and referring to the auditor's books for their location in the proper section or fraction.

A final map of the county of Jackson, is executed in accordance with your directions, embodying, in addition to the geographical details enumerated, the geological information indicated upon the skeletons returned to me. No other entire county has been placed in my hands by the geologists.

Character of the country.

The external characteristics of the county of Jackson, the southeastern part of Ross, and the eastern portions of Pike and Scioto, the only districts to which I have given personal examination, are quite similar. Along the right bank of the Ohio an abrupt bluff, apparently 300 feet high, overlooks a valley from half a mile to a milo and a half in width, fronting a similar range upon the left bank. The Ohio river occupies of this space, at ordinary stages, an average of 1750 feet, or about one-third of a mile, crossing from side to side in ample curves. The bluff is continually broken by the passage of water courses that (however small,) wear their way down through the soft rock of this region, to the level of the river. Consequently, lakes, swamps, and waterfalls are uncommon, notwithstanding the semi-mountainous character of the country. On the left bank of the Scioto, from its mouth at Portsmouth to Chillicothe, a line of steep hills, limits the valley on the east, met by a corresponding elevation on the west. The trough of the Scioto is, however, wider than

the Ohio, being from two to four miles, through which the stream, 25 rods in width, courses at random in a very crooked and irregular manner. The vicinity of both rivers, presents occasional *lagunes;* those on the Ohio much above the general level of its waters, and therefore capable of drainage; while those of the Scioto are not so, being chiefly caused by the absence of the stream from its former bed; and consequently, nearly or quite as low as low-water.

This river, which passes the surplus water of 2600 square miles, rises 15 to 20 feet, at a point of the stream, above where it is influenced by the reflux of the Ohio. Its channel is continually changing; sometimes by the ordinary action of the current upon its alluvial banks, but more often by the force of violent floods, which cut through the necks of land, forming what are there termed "*thoroughfares.*" Previous to the construction of the Ohio Canal, it was the channel of commerce for the produce of its shores; but at all times uncertain, dangerous and expensive. Owing to the want of proper instruments, the elevation of the general surface of the country embraced between the Scioto and Ohio rivers, has not been ascertained; but the summits of the thousand cone-shapen hills that cover its whole territory. seem to lie in one plane, which inclines slightly towards the junction of the two streams. Ascending the Scioto, these hills are less elevated, with reference to the river, and their bases enlarge in proportion. The same is observed, if we go interior from either stream, until at the distance of a few miles the inclination of their sides diminishes, they become capable of cultivation; and when improved, furnish excellent pasturage, especially for sheep. No regularity is perceivable in the location of these knobs, and nothing like ranges in the bluffs, except at the dividing ridges between streams. In the extreme eastern part of Scioto, and I am informed by James Rodgers, Esq., of Hanging-Rock, the northwestern part of Lawrence, there is a *back-bone* or narrow ridge, wherever the water flows away in opposite directions, frequently extending many miles in an unbroken yet serpentine course, at an apparent level, and seldom wider than an ordinary road. An inspection of the county maps, with the endless creeks and minute branches there exhibited, will convey a clear idea of the manner in which this country is intersected, bearing in mind, that all water courses, where there is a permanent flow, lie from one to three hundred feet below the adjacent knobs or bluffs.

Streams.

From the southern part of Jackson county, streams descend in every direction. The south fork of Salt creek northwardly, the Little Scioto and Pine creek, to the south and west, and Symmes' creek eastwardly. Many water courses take their rise along a north and south line, passing a little east of the centre of this county, flowing thence to the middle fork of Salt creek, and to the Big Raccoon.

The united branches of Salt creek reach the Scioto near the south line of Ross county; the Little Scioto empties into the Ohio, seven miles east of Portsmouth; Pine creek three miles higher up; and Symmes' creek five miles east of Burlington, the capital of Lawrence county. These, with Beaver creek, of Pike county, are the principal creeks of the section under consideration. They are excessively crooked, with narrow valleys, attended by high hills. Symmes' creek, Little Scioto, and the middle and south forks of Salt creek, are of some value for hydraulic purposes;

but they all possess the same characteristics—a sluggish current, high floods, and a deficiency of water.

The main Scioto in the lower portion, is too transitory and unmanageable for manufacturing uses; the Ohio canal however, may receive its waters, and in a measure supply this deficiency.

Jackson County.

Along the middle fork of Salt creek, from its mouth to where it branches, the knobs stand in thick succession upon both sides, at an apparent altitude of 350 and 400 feet; sometimes extending along the bank in an elongated manner, a few hundred yards; but having in general a circular base of about three times the height, and an unbroken slope from the summit down. The most elevated points of this wild region lie east of the south branch of Middle fork, in Washington township. Down the valley of this branch passes the great "Buffalo path," leading from the licks at Jackson, to licks upon the north fork, about thirty miles distant. It is at present distinctly traceable throughout, over hills and across valleys, and pursues the most direct practicable route. The appearance is that of a gully, cut in the soil from one to four feet deep, by a sudden torrent, and partially filled again by the effects of time. There are occasional cavities called "Buffalo wallows," where it is said the animal amused himself in his travels, by rolling and pawing in the dust, like cattle. It appears by a statement of Mr. Edward Byers of Jackson county, that individuals of the Buffalo race have been killed on Raccoon, Symmes' and Salt creeks, within thirty years.

The scenery of Little Raccoon, a branch of Raccoon Creek, is quite similar to the Middle Fork; and equally romantic. About twenty miles of this stream passes through the townships of Clinton, Milton and Bloomfield, comprising nearly its whole length; in size, it is less than the South Fork. Along the latter creek, between Strong's mill and Jackson village, sand-rock bluffs, with mural fronts, rise alternately on each bank, from the edge of the water. The remainder of its course presents a topography similar to the Middle Fork; the knobs, however, are less elevated above its bed; showing cliffs of sand-rock occasionally near the top. At the bridge, two miles southeast of Richmond, high-water mark appears to be fifteen feet from low water; and at a bridge near the mouth of Middle Fork, the inhabitants put the highest flood at twenty feet. The width of South Fork at Jackson, is 35 links; at the bridge spoken of, 60; Middle Fork is 54 links wide where it branches, and 90 at its mouth. The knobs in the northern and eastern part of the county, produce pine timber on their *northern* and *western* slopes, from the peak *two-thirds* of the way down. The other portions are covered with handsome oak. There are 12 saw-mills in this county; *lumber*, *coal* and *tar*, forming its present exports. In early times *salt* was its main product, but none is made there now. Pursuant to its general rule, of May 18, 1796, Congress reserved what was equivalent to a township of six miles square, about the main springs, which includes the village of Jackson; and December 28, 1824, it was bestowed in fee upon the State, for literary purposes, divided into 80 acre lots, appraised and sold, but the avails were small. The salt wells are now considered of no value, and, compared with western lands, the donation was, in other respects, unsaleable.

Timber.

The timber upon the Scioto bottoms, in the lower portions of the valley, is, sycamore, cotton-wood, and black-walnut; of the inclined upland, connecting the bottoms with the hills, a general mixture of western trees, including locust and paw-paw, (and, excepting the chesnut,) the upland is mostly timbered with some, or all, of the varieties of the oak. The intervale of the Ohio produces beech, hickory and maple, with sycamores and elms at the margin of the stream.

Levels.

Respecting the levels you have instructed me to take, under the direction of the active geologist, for the purpose of giving the survey a character of mathematical accuracy, heretofore unknown in the progress of geological investigations, nothing has been done in the field. The instruments ordered from the East were, unfortunately, detained on their route, and did not arrive until the 5th instant, while every exertion, on my part, to procure a level for the purpose here, has failed. In aid of this object, however, I have spent some time in collecting and arranging the results of former surveys made within the State. Had the work of all the Engineers in the employ of the State, and of the various Railroad, Canal and Turnpike Companies, been preserved in an intelligible form, there would have been at this day, very few points of consequence, whose precise altitude, with reference to the Ocean, or the Lake, would not be easily known. Yet, with the records of levels within reach, additional surveys of a few miles, branching from the main lines, will leave nothing to be desired in this respect. The explorations for public, as well as private works, are very seldom connected with each other, where the different lines intersect by natural marks or monuments; nor are other routes noticed on the minutes of the Engineer, as he passed. From this cause, and an absence of vertical sections or profiles, of the early surveys, from the files of the Board of Public Works, it is not often that data can be found, whereby to correct and reconcile perplexing variations that exist in some of the returns; but those discrepancies are confined to the early random lines, and are *too small* to destroy the value, even of *this part* of the collection, in determining the general thickness and inclination of strata. A sheet of projections is constructed, showing, at a glance, the vertical relations of many important points, distributed through all parts of the State, and this will be filled out as the necessary information is obtained. The surface of Lake Erie, 564 feet above tide-water, at Albany, is made the plane of reference. This comparison of heights exhibits almost the entire surface of our territory above the level of the Lake. The Ohio river, at Cincinnati, in its lowest stage, is but 133 feet below (that is, nearer the Earth's centre, than) the Lake's surface. Ascending the river to Portsmouth, it rises 37 feet, being 96 beneath the Lake; to Marietta 94 feet, within two feet of the line or plane of reference; and at Beaver, Pennsylvania, its elevation above the waters of Erie, is 127 feet, according to the best information. The highest annual floods lessen the difference between the river below Marietta and the Lake, about 50 feet, and increase the same as we ascend. But the increase of difference is not equal to the decrease, as each tributary, when all discharge surplus water at the same time, of course gives additional height to its waters; yet the extraordinary inundation of Febru-

ary, 1832, which H. G. Eastin, Esq., an Engineer in the employ of the State of Kentucky, puts at 61 feet in the vicinity of the mouth of Big Sandy, was only one foot higher at Cincinnati. From Beaver to Cincinnati, by river, 420 miles, the descent is 260 feet, or 619-1000ths of a foot per mile. But the fall is not uniform, being greatest in the upper part of the river, thus: From Beaver to Marietta, it is 0,86 of a foot per mile; Marietta to Portsmouth, 0,563; Portsmouth to Cincinnati, 0,359. The upper level of the Canal, in the northern part of Cincinnati, is only 21 feet lower than the Lake; the intersection of Main and Cross streets, Aberdeen (opposite Maysville,) 28; and the sill of the Old Court-House, at Portsmouth, in Market street, (about 100 feet north of Front,) is but 35 feet below the line of reference, made use of on the sheet of projections. The elevations of the bluffs and knobs bordering on the Ohio river, have not been taken this season, for reasons above given. They have an apparent height of 300 and 400 feet above our general standard (the Lake,) leaving only a small portion of the immediate valleys of the Ohio, the Scioto and the Miamies, beneath it. The sill of the Court-House, at Piketon, is above, a few inches less than 8 feet. The "Little Mountain," a singular elevation in Mentor, Geauga county, about 5 miles from Lake Erie, and the highest point in the northeastern part of the State, rises but 5 feet above Somerset, in Perry county, and 40 feet higher than the door-sill of Hillsborough Court-House, in Highland county, in the southeastern section of Ohio. This striking feature of uniformity in the general surface of the State, cannot be more plainly exhibited, than by a tabular statement, drawn from the materials hitherto collected, showing in contrast, some points, remote from each other, but of corresponding elevation above Lake Erie—

Hillsborough, Highland Co.,	560.	Highland, west of Akron,	(same.)
West Union, Adams Co.,	410.	Huron Summit Swamp,	414.
Yellow Springs, Green Co. (Cokely's door sill,)	398.	Portage Summit,	395.
Mahoning Summit Swamp (Champion, Trumbull County,)	342.	Kilbuck Summit Swamp, (Harrisville, Medina county,)	337.
St. Mary's, Mercer County, (Canal Level,)	278.	Olentangy, at Delaware,	278.
		Killbuck, at mouth of Apple Creek, near Wooster,	278.
Scioto, at mouth of Mill Creek,	271.	Newark, Old Court-House door sill,	272.
Columbus, west door-sill, Capitol,	197,5.	Walhonding, at mouth Killbuck,	197.
Sinking Spring, Adams County,	150.	Putnam, Muskingum County,	150.
Scioto, at Columbus Feeder	128,75.	Muskingum, at Dresden,	127.61
		Ohio, at Beaver, Pennsylvania,	127.
Fort Defiance, (Canal level)	98	Cleveland Court-House,	95.

It will be seen that the places compared are similarly situated, i. e. Summits stand in contrast with summits, and streams and places upon them are collated with each other.

Ancient Works.

Pursuant to the liberal spirit, and apparent intention of the act of March 27, 1837, I have inspected the ancient remains within the district embraced in this season's operations, and have sketches and notes of nine

separate works. Further exploration and measurements are necessary, however, to render complete the plan, specification and detailed description of most of them. These plans will exhibit the figure of each ruin, as far as it can be traced upon the ground; the elevation and depression of its embankments and excavations, by means of vertical sections or profiles, and a topographical sketch of the vicinity. A plan of the remains at Marietta is nearly finished, and may serve as a specimen of the general method, according to which, it is proposed to execute the whole set.

Many of these ruins of a lost race, are to this day without a description, while their forms and dimensions are fast disappearing under the operation of the plough and the spade. For it is in the rich valleys of the Miami, the Scioto, and the Muskingum, where the modern agriculturist now cultivates the soil, that an ancient people, more numerous than the present occupants, pursued the same peaceful avocation at least ten centuries ago. And upon the sites of modern towns within these valleys, as at Cincinnati, Chillicothe, Circleville, Piketon, Portsmouth and Marietta, the ancients located *their* cities, of which distinct traces exist. They also occupied many other points upon the rivers named, of which evidences remain too plain to be misunderstood. Large works are found on the Scioto in addition to those first mentioned, in ascending; *first*, between the road and left bank of the river, about five miles south of Piketon, on sections 10 and 11, fractional township, adjoining westerly township 4, range 21, on Vulgamore's land. *Second*, on left shore, a short distance below Kilgore's mill, four miles south east of Chillicothe, sections 2 and 3, town 7, range 21. *Third*, on tho road from Chillicothe to Richmond, three miles beyond Kilgore's mill, at Richard Alderson's house. *Fourth*, about thirteen miles north of Chillicothe, near the Canal. On Paint creek, and the Olentangy, near Worthington, similar works are found. Research and inquiry will doubtless develop a connected system of antique structures, upon all the tributaries of the Scioto, and its kindred streams, leading to the Ohio. The interest manifested by the learned abroad, relative to these works, and the hasty and imperfect sketches taken of them by travellers, in addition to a local curiosity respecting our predecessors upon this soil, and the other considerations above named, seem to demand of us, a thorough record of what remains to our observation. A general description will accompany the plans when complete, for which it is proper to reserve observations. But the popular name of "fortifications," bestowed upon these ruins, leads me to state that, I have *seen* none to which the term is applicable. I have examined the extensive works at Marietta, and those more extensive ones at, and in the vicinity of Portsmouth—at Vulgamore's, in Pike county—at Piketon—at Kilgore's, in Ross county, and at Alderson's—with other lesser, and detached works, and can discover in none of them, elements of military strength, or evidences of a warlike intention. The principal enclosures are rectangles, or circles, weak figures, without ditches, made weaker by numerous openings, not only in the sides, but at the corners. The subordinate parts of large works, and the small isolated ones, *sometimes have ditches*, but always, as far as I have seen, on the *inside*, though cases of extensive fossa, are said to exist. The main figure always occupies ground accessible on all sides, and no spring, or receptacle of water, is found *within the walls*. Other equally good reasons might be advanced, why these structures are not adapted, and were not designed, either for attack or defence, under any supposable mode of human warfare.

No portion of Ohio appears to be destitute of ancient tumuli and embankments; the object and origin of which are still, in a great measure, mysterious and unknown. They are said to have been discovered, by uncertain traces along the southern shore of Lake Erie, at Salem, in Ashtabula county—on the Vermillion, near its mouth—and in the vicinity of Maumee river. Caleb Atwater, Esq., the pioneer in antiquarian researches at the west, describes a most ample construction in the vicinity of Newark: one enclosure, containing 40 acres. Also, an irregular figure in section 21, town 7, range 16, Perry county, of the same contents; corresponding in this respect, with the large square work at Marietta. The same author has given the details of a circular and square structure in Circleville, attached to each other—of an interesting and extensive remain on the Little Miami river, in Warren county, a few miles above the mouth of Todd's Fork; and some lesser works. Similar ruins are spoken of on the left bank of the Great Miami, five miles from its mouth—on the hill, two miles from Hamilton upon the right bank—and in the vicinity of Dayton and Piqua. Others are said to be known on the Little Miami, near Milford—near Deerfield—at the upper part of Round Bottom—and at the sources of East Fork. In the neighborhood of Athens—at Cats creek, Washington county—in Belpre, in the same county—near Jackson Court House, on sec. 19, town 7, range 18—and on the Ohio Canal, west side, above the mouth of Pond creek Entry 1,270, Virginia Military Reservation,—distinct enclosures, of various and fantastic forms, still remain. The evidences of remote population and labor, now apparent within the State of Ohio, will, when collected in one mass, surprise all who have not bestowed attention upon the subject of Western Antiquities,

Repetition of Names.

There are in this State, thirty-five townships and villages called Washington, twenty-nine named Jackson, twenty-one Monroe, the same number of Waynes, nineteen Franklins and Madisons, sixteen Jeffersons and thirteen of the name of Harrison. Many less extensive repetitions might be added, and every year increases the number. The counties of Fairfield, Franklin, Pickaway, Fayette, Perry and Highland, all immediately adjoining, are each furnished with a township called Madison; and it will be seen that almost one half of the counties in the State contain a Washington. Great complaint is made of irregularity and delay in the reception of intelligence by mail, at interior post-offices, much of which is traced to unavoidable errors in the direction of packages, arising from this multiplicity of identical names.

Survey of Streams.

The present opportunity is favorable, to the meandering of all streams of a less magnitude than those called navigable, (and already surveyed and recorded by the public surveyors,) but large enough to be of importance for hydraulic purposes; say down to a width, at ordinary stages, of 50 links. Or at least the water-courses, Lake shore and marshes covered with water, in the "Virginia Military Reservation," the "Western Reserve," and parts of the "Military Bounty Land." Many streams of the second class, are already traced, in connection with the public works, and plans are returned to the office of the Board.

It is well known that the Virginia Military Land Warrants, were located without any previous survey, with the exception of a tract north of the Indian Boundary, established at Fort Greenville in August, 1795. All the country between the Little Miami, the Scioto and the Ohio, was dedicated to these warrants; and aside from the tract just mentioned, (and the still unlocated and waste portions of at least 200,000 acres,) the whole district is subdivided into irregular parcels, according to the fancy and interest of the proprietor.

Previous to the "Deeds of Cession," much land had been entered at the Virginia offices, of which the surveys were discordant, incomplete, and not fully returned. Little more system has prevailed in the greater part of the subsequent selections; and the special office for that district, at Chillicothe, now under the control of the United States, is unable to furnish a true map of the lot lines, much less of the interior streams. In this connexion, another important matter presents itself, in reference to the Virginia Reservation. A custom has prevailed of "locating," by extending the corner monuments, *more acres* than the warrant specified; *land marks*, controlling course, distance and quantity. The whole tract is entered, and taxed, from the description in the warrant. If subsequent sales are made of portions of the entry, the deed commonly shows the true quantity transferred, and the proprietor who retains the balance, is taxed for the difference only between the deed and the warrant. Great inequalities arise in this way, in the *taxation of property;* and where a county is composed in part of Congress lands, whose quantity is known, and partly of Virginia Military Lands, the inequality assumes a sectional character. It has been strongly represented, that justice and policy require a resurvey of the warrant entries, either at the expense of the county, or State, in order to equalize taxation. This work would locate the streams, and supersede the necessity of the partial survey suggested. It is not in my power, at present, to give the expense of a resurvey of the entries; but an idea of the importance of it may be drawn from the imperfect statement which follows, and also from the fact, that an offer was made by a Surveyor, some years since, to the Commissioners of Franklin County, to resurvey that part within the Military District, in consideration of an assignment of the taxes upon the overplus, for five years. A computation, made by the aid of township maps, in the office of the County Auditor, gives 136,396 acres, as the contents of Franklin County, west of the Scioto. The quantity returned for taxation on the duplicate, is 120,249, leaving 16,147 untaxed. By a law, directing the survey of a portion of the boundary of Clinton County, it is to be run so as to give the constitutional territory 400 square miles, or 256,000 acres, and this County returns but 246,657 for taxation. E. P. Kendrick, Esq., who is connected with the Virginia Reservation Office, at Chillicothe, says, "We consider the District lying North of a line West from this place, entirely taken up and located. Most of the vacant land is in Pike, Scioto and Adams; there is some in Clermont, Highland and Brown, and the South part of Ross."

The Reservation embraces eight entire Counties, with considerable portions of ten more. On the supposition, that the parts of Scioto, Pike and Ross, are equivalent to all the *unlocated* lands in the District, and that the remaining fractional Counties are equal to four complete ones, we have twelve counties of land, where the excess, whatever it may be, escapes taxation. The average quantity of real estate exempt, according to the rough calculation above, combined with an uncertain estimate in

Pickaway County, is about 16,000 acres per County, or 192,000 acres in all, if the data can be relied upon. Thus, one-eighty-fifth part of the taxable land of the State is relieved from its share of the public burdens, and mostly for the benefit of non-resident proprietors.

The "Bounty Lands" being all *North* of the North line of Township 8, Range 8, West of the Pennsylvania line, produced, westward, to the main Scioto, (two miles North of Columbus,) *East* of Scioto, *South* of the Greenville treaty line, and *West* of the West line of the "Seven Ranges," was surveyed, by order of Congress, into blocks or townships of five miles square, which were quartered, making tracts of 4,000 acres, through which no lines were run. A small portion was then cut into 100 acre lots, and recorded; but the private subdivisions, if on record in the counties, seldom notice the streams. In the "Western Reserve," lying between a line, extending 120 miles West from the Pennsylvania line, on the 41st parallel of North latitude, and Lake Erie, the Federal Government never held proprietary rights. Here, the township lines were run at intervals of five miles, and, according to the true meridian; but the subordinate surveys are without similarity, save that the lots are generally rectangular; the streams being seldom, or inaccurately noted. The "Ohio Company's Purchase," and the "Symmes' Purchase," are allotted as Congress lands; but, even under that method, the creeks escape observation between section lines.

Unsurveyed Shore.

The Ohio Canal, as finally located, will require to be meandered in many parts, before it can be laid down in proper connection with lot or section lines; and parts of other works may be found in the same condition. By a statement of Samuel Williams, Esq., Chief Clerk in the Surveyor General's Office, Cincinnati, it appears that the Ohio river, from the mouth of Little Miami to Portsmouth, 100 miles, and along the Ohio Company's Purchase, about 120 miles, has not been meandered.

The shores of Lake Erie and Sandusky bay, East of the West line of Huron County, have not been accurately determined. The amount of stream, over 50 links wide, as yet unsurveyed, cannot be estimated with accuracy. In the Western Reserve, there would be, including Lake Erie and interior Lakes, from 150 to 200 miles of shore, per county. The other counties would average from 100 to 150 miles of water course, exclusive of the Ohio, of which a full survey is in progress, under the care of Lieut. John Sanders, of the Engineer corps. Unless the Geological examinations be expedited, in the coming season, so as to render an Assistant necessary, the increase of expenditure for this work will be trifling. In any event, the additional cost, in fact the entire expense of the topographical branch of the survey, may be easily refunded, and the citizens of the counties greatly commoded by the publication upon a suitable scale of the manuscript county maps, constructed for the geologists.

I cannot close, without a public reference to the universal kindness and hospitality, manifested by the citizens, with whom I have been brought in contact the past season, and especially to the marked politeness and readiness exhibited by those gentlemen connected with the Public Offices, of all kinds, in affording every facility for information connected with the survey.

CHAS. WHITTLESEY,
Topographical Surveyor.

COLUMBUS, *January* 6, 1838.

RECAPITULATION OF SUBJECTS.

No. 6.

GEOLOGICAL QUERIES.

A geological survey of the State of Ohio has been commenced, in compliance with an act of its Legislature.

With a view to facilitate the progress of the survey, the following queries are propounded to the people of the State, hoping that every one who is interested, either in having the mineral wealth of his farm known, or in advancing geology and its kindred sciences, will contribute such aid as may be in his power. The local knowledge of individuals may be of great importance in expediting the survey.

We would suggest to proprietors of estates, that they forward to Columbus specimens of the minerals, rocks, petrifactions, and soils, to illustrate the nature of the materials of their lands. The mineral wealth, as well as the agricultural value of a farm, should be known, before a correct estimate of its worth can be formed. Our land owners are more immediately interested in the geological survey, than any other class of the community, and they will appreciate the importance of having the mineral products of their land represented in the State Cabinet.

Individuals and associations are requested to lend their aid in advancing their own, and the public interests. Boxes may be sent, directed thus:

W. W. Mather, S. G.

Care of Jos. Ridgway, jr.

Columbus, Ohio.

Letters should accompany the boxes, or be sent by mail, describing them. A concise abstract of general directions for selecting geological specimens, and observing geological phenomena, will be found at the end of the queries.

Letters from the various parts of the State, containing local information upon any subjects embraced in the queries, may be addressed to

W. W. MATHER,
State Geologist, *Columbus, Ohio.*

Rocks.

1. Have *ledges* of rock been observed in your vicinity?

2. Are the ledges on the sides, or on the summits of hills; on the shore, or in valleys?

3. Are the rocks divided into regular layers?

4. Towards what point of the compass do these layers pitch with the greatest declivity?

5. Are there veins of other rocks traversing those before mentioned?

6. In what direction do these veins cut through the rock, and are they perpendicular, or inclined?

7. Have any ores been found, either diffused through the mass of rock, or in separate beds or veins?

8. Have any useful, or curious, or rare minerals, been found in the rocks or veins?

9. What names are commonly used to designate the rocks, ores, minerals, &c., referred to?

10. Have they been applied to any useful purposes?

11. Where ledges of rock have been recently uncovered by excavations, are the surfaces smooth, as if by the action of running water, or with pot holes, such as are seen at many water falls?

12. Do any of these surfaces show grooves and scratches, as if hard masses had been dragged over them?

13. Do the rocks recently uncovered show traces of the shells of barnacles, or other marine remains, attached to them, in sheltered situations, and much above the level of the sea?

14. Are shells or petrifactions of any kind, or the remains of plants, found in any of the rocks, and in what kinds of rocks do they occur?

15. Do the rocks which are exposed at the surface, or buried at moderate depths, show any tendency to disintegration or decomposition?

16. Are rocks found to be decomposed, in their natural situation, (in situ,) into stratified clays, sands, loams, gravel, &c.?

17. What is the texture of the rocks; porous, like sandstone, or compact and impenetrable by water, like compact limestones; slaty, or granular, or crystalline like granite and some marbles?

18. Do the rocks indurate, or become harder and stronger, after removal from the quarry?

19. Are saline substances, such as salt, alum, copperas, nitre, gypsum, &c., seen efflorescing on the surfaces of the disintegrating rock?

20. Where water carries off the efflorescing saline substance among the leaves of oak and other trees, are the leaves or water changed in color?

21. Are slate, limestone, sandstone, granite, gneiss, &c., found in your vicinity?

22. Where rocks of different kinds come in contact, is there any change in their characters near their junction?

23. Do the rocks show distinct lines of demarcation, or do they gradually blend into each other?

24. Where fissile stratified rocks occur, are the laminæ parallel to to the strata?

25. If the laminæ be not parallel to the strata, is there any regularity in the angle of inclination of one to the other?*

Sands.

1. Are there any beds of fine white sand, or sandstone, which contain no black, or red, or yellow grains?
2. Has it ever been used for making glass, or for other purposes?
3. Are there beds of red, or black sand, washed upon the beach of the lake?
4. Are these sands abundant enough for purposes of commerce?
5. Have they ever been used as iron ores, or as a substitute for emery, or for blotting sand?
6. Do any of the metallic sands yield a bright red powder?
7. Is the general surface of the country sand, clay, or loam?
8. Do these materials form alternating regular layers?
9. Does the sand on the surface of the country drift by the wind?
10. Have any farms been thus materially injured?
11. Have buildings, trees, hedges, fences, or wells, been covered from this cause, or marshes or ponds made dry land?
12. Do the sands progress in any particular direction, and at what rate per annum?
13. Is the sand, in any locality, hardened into a sandstone?
14. Is sand washed along the shore by currents, and deposited in new situations?
15. Are any islands, sand bars, spits, shoals, or beaches, known to have been thus formed?
16. Have islands been connected with each other, or with the main land, by bars, spits, or beaches?
17. Have islands, or coasts, been washed away entirely, or in part, by the action of the waves?
18. Where cliffs have been undermined, and have tumbled down, what kinds of earth or rock were exposed?
19. Were they arranged in layers?
20. Were bones, shells, bits of blackened wood, leaves, or seeds, or any vegetable matter, imbedded in them?

Clays.

1. Are any beds of clay known in the vicinity?
2. Are the beds extensive, or of small magnitude?

* The sedimentary sandstones, at the Grotto of Plants, near Marietta, show the character referred to, with all the varieties of interlineated strata which are so frequently observed in the tertiary and alluvial sands.

3. At what depth do they lie below the surface?
4. What is the thickness of the bed or beds?
5. What materials were observed in digging down to them?
6. Are the clays in thin layers, which easily separate?
7. Do the beds of clay alternate with beds of sand and gravel?
8. Are the layers of the beds of clay, gravel, or sand, inclined, or are they level or undulating?
9. What is the color of the clay?
10. Is it mixed with sand, or is it free of grit?
11. When mixed with water, does it form a tough and plastic mass, or does it crumble to a pap?
12. When heated red hot, does it become red, brown, or white?
13. To what useful purpose has it been applied?
14. What quantities are annually exported, and for what purposes?
15. Has it been tried as a manure for sandy soils?
16. Do balls or flat rounded masses of a hard earthy mineral occur in the clay?
17. Are they arranged in layers parallel to the layers of clay?
18. Are they of the same materials as the clay?
19. At what depth from the natural surface are they found?

Water springs, &c.

1. At what depth is water obtained?
2. What strata are passed through before reaching it?
3. Does clay, loam, or rock occur at the level of the springs?
4. Is the water "hard," or "soft," as these terms are usually employed when speaking of water?
5. Did the water percolate gradually into the well, when first dug, or did it come in a strong stream?
6. Have shells, bones, pieces of blackened wood, or common wood, beds of marl or clay, been observed in digging wells or cellars, or by the caving down of cliffs or banks on the shore or by the sides of streams?
7. Have mineral springs been discovered?
8. What is their taste: sulphurous, inky, pungent, or saline?
9. Is there any sensible odor to the water? What is it like?
10. Is the water sparkling, like bottled beer; and does air bubble up from the fountain?
11. Is there a reddish or yellowish deposite where the waters flow off, or in the adjacent meadows or ponds; or is there a similar oily scum on the water?
12. Do sticks, mosses, leaves, &c., become incrusted with or imbedded in a hard stony coat, or is there a gray or yellowish rock forming near the spring by a deposite from the water?
13. Where such rocks are formed, are leaves, sticks, reeds, grasses, land shells, or pebbles found imbedded in the concreted rock; or have these substances decayed and left their moulds or impressions repre-

senting the exact form of the body originally imbedded; or is the original body petrified, and converted into stone, but still showing its organic structure; or are they casts representing the exterior forms but not the organic internal structure?

14. Do such masses of rock descend the hills from the location of the springs, forming a mass of rock different in appearance from the common rock of the country around?

15. Where such masses of rock encounter a stream, are they continued across it, or are they found to stop short, forming overhanging cliffs, with pedulous masses of the same material hanging from the cliff, like icicles and stalactites?

16. Has the mineral water been used in the cure of any diseases?

17. Is the spring copious?

18. Do large springs burst from the earth?

19. What is the temperature of the springs?

Salt springs and licks.

1. Are any salt springs or licks known in your vicinity.

2. Did the salt water flow there originally, or is it owing to salt wells having been bored through the rock?

3. Has a record of the strata, with their thickness, or a suit of speci mens to illustrate their nature, been preserved?

4. At what depth has the salt water been found?

5. Does it flow at the surface, or is it pumped up?

6. What is its strength?

7. What is the mode of manufacture?

8. Are any difficulties encountered in making good salt, and what are they?

9. What impurities are in the brine?

10. How are they separated?

11. What is the temperature of the water as it flows from the well?

12. Do petroleum, or mineral oil, and tar flow with the salt water?

13. Does carburetted hydrogen issue from the licks and wells by constant bubbling up, or rush up in paroxysmal eruptions?

Subterranean forests.

1. In digging wells, or other excavations, or by the caving down of banks or cliffs of earth, have any traces of trees, wood, bark, leaves, nuts or seeds been discovered much below the surface of the earth?

2. Were these remains in their natural state, or were they converted to stone, or to a black substance like charcoal?

3. If the latter, has the substance been used for fuel?

4. At what depth does it lie, and in what earth, (sand or clay?)

5. What strata were observed above and below?

6. Do the trees stand erect?

7. Do they lie all in one direction?

8. Do you suppose drifting sands, washing by water, or other causes, have buried them?

9. What is the situation of this lignite, with regard to the water courses, and its relative height or depth above or below them?

10. Have shells or bones been found in the layer containing the lignite, or in the adjacent strata?

11. What is the color of the adjacent clay, sand, or gravel?

12. Have masses of a heavy, yellow, metallic stone (pyrites) been found in the adjacent clay, and has it been applied to use?

Peat bogs and shell marl.

1. Are there inland meadows or swamps in your vicinity that tremble when one walks over them?

2. Are they covered by moss and cranberry vines?

3. To what depth can a pole be thrust down?

4. How many are there, and of what extent, in your vicinity?

5. Does the peat, or black tremulous mud, rest on sand, gravel, rock, or a white clayey marl, containing small shells?

6. Has the peat been used for fuel, or for burning lime or bricks?

7. Has the peat, or shell marl, been used as a manure?

8. Are there lakes or ponds, which have a white earthy substance (marl) in them, which contains small shells?

Bog Iron Ore.

1. Are there ponds or marshes in the vicinity, in the bottom of which is a soft spongy, yellowish brown stone or gravel?

2. Does it originate from mineral springs, or from stagnant waters?

3. Does such ore occur in banks, on the sides, or at the base of hills, in valleys, or in streams?

4. Has it been used an as iron ore?

5. Is it in such quantities as to be useful?

Marshes.

1. Have the marshes on the borders of lakes, on the banks of streams, or on the flat table lands in your vicinity, changed materially within the period of history, or within the remembrance of old inhabitants?

2. Have they become more wet, and risen so as to cover land before dry?

3. Have they sunk in level, and from what cause?

4. Have they become more dry, and from what cause?

5. Have they changed in the natural growth of the soil?

Lakes and Drainage of Lakes.

1. Has there been a periodical variation of level on our Lake coast, the rise and fall of which has occupied a series of years?

2. Is Lake Erie now at a higher or lower level than it was a few years ago?

3. If so, what is supposed te be the cause?

4. Is there a tidal swell on the lake, and which is distinct from the irregular flux and reflux caused by the changes in the direction and force of the wind?

5. Are changes now being effected on the lake coast, either by wasting away, or by the formation of new land?

6. To what cause do you attribute them?

7. In what localities are such changes going on?

8. Are there any evidences of the lakes in your vicinity having once occupied a higher level than they do at present?

9. Does this evidence consist in elevated beaches, or the cutting down of their outlets, or both these combined?

10. Are there valleys which seem to have been once lakes, and what evidence is there on this point?

11. Are there regular stratified deposits of clay, sand, gravel, &c. in the valleys?

12. Are there terraces in the valleys, indicative either of ancient beaches, or of such slopes as are formed by the retiring surge on sandy coasts?

13. Are remains of plants or animals found in them?

14. In the gorges at the outlets of lakes, or along the courses of the streams which flow from them, are there marks to show the wearing action of water much above its present level?

15. Are there deep defiles through the country, through which the water flows, or seems to have once flowed?

16. What is the nature of the strata of those defiles, and generally of the country at any of the particular localities, to which you may have referred?

Rivers and River Alluvions.

1. Are the rivers and streams in your vicinity, deepening their channels, or raising their beds by the deposit of alluvial matter?

2. Do you know of instances of lateral streams bringing in such uuantities of alluvial matter, and of so coarse a texture, that the larger stream is unable to sweep it away, and which might cause the formation of lakes in the valleys above?

3. Are the rivers or smaller streams lost by sinking in the ground?

4. Do the flats of ooze and of sand along our rivers increase in magnitude, or rise in their level, in any perceptible degree?

5. To what cause do you attribute it?

6. Has the increase been more rapid of late years than formerly?

7. Are alluvial islands of sand, or of ooze, or shoals and flats of the same, washing away?

8. Do the flats, shoals, or islands near the mouths of rivers and streams increase sensibly in magnitude?

9. What is the mean quantity of water passing through ——— river per day?

10. What relative and absolute quantities of matter are held in solution, and what in suspension, during low stages of water, and during freshets?

11. Is the transported alluvion of rivers deposited in shoals, bars, and islands near their mouths?

Rolled masses, pebbles, and erratic blocks.

1. Are any large rounded or irregular masses of rock found in your neighborhood?

2. Do they occur mingled with gravel and pebbles, or are they isolated on the surface, or imbedded in the earth?

3. Do they crumble away by the effects of the weather?

4. Are they smooth, or nearly so, like pebbles?

5. Are there scratches on them, in one or more directions?

6. Are there ridges on them in one direction only, from the harder points of the stone, and parallel to the scratches?

7. Are these rounded pebbles all of one kind of rock?

8. Do these boulders or blocks occur singly, or are they in groups?

9. What rock or rocks constitute these masses and pebbles?

10. Are they similar to ledges of rock known to you, either in the vicinity or elsewhere?

11. Are barnacles, or other shells, or the remains of marine animals, observed on them when they are at a distance from the sea or buried in the earth?

12. Has ice been known to move masses of rock in ponds, streams, bays or inlets?

Elevation of land.

1. Are there beds of rock containing remains of animals or plants whose proper habitat is the ocean?

2. Are the rocks horizontal or inclined?

3. Are they bent, contorted, or are they dislocated?

4. What is the direction of the line of bearing of the strata?

5. Is there any evidence that the rocky strata have been elevated at one or at several epochs? If at one epoch, all the strata are conformable up to the time of its occurrence, unless in the rare case of elevation without derangement of the dip. If at several, the strata formed subsequent to each of these epochs are successively unconformable to those below, with the same exception as above.

6. Are the axes of elevation parallel, or do they intersect, and wha. are their directions?

7. The occurrence of anticlinal and synclinal lines, and their directions, should be particularly noted.

8. Are the rocks intersected by regular fissures parallel to each other, and dividing them into large masses?

9. Are there two or more systems of these fissures, uniform in direction in each system?

10. Are these systems of fissures vertical or inclined, and towards what points of the compass do they trend?

11. Are they uniformly smooth, with a plane surface, as if cut through with a saw?

12. Can faults be traced along the base of steep escarpments of rock, where streams or artificial excavations expose transverse sections of the strata?

13. Can dykes, or masses of trapean or other igneous rocks, be traced along the line of fault, or of any up-heave of the strata?

Agriculture, manures, &c.

1. What manures are employed on the soil?

2. Has a rotation of manures been tried?

3. What rotation of crops is employed on the light, and what on the heavy soils?

4. Have changes of rotations of crops been tried, and with what success?

5. How are your manures prepared?

6. Does lime, or ashes, or marl, or gypsum, or barilla, enter into the composition of the compost heap?

7, Has salt, or nitre, or copperas been tried in small quantity on the land as manure?

8, Has the black ash of the soap boilers, or the bitter water of the salt makers, been used as a stimulant manure?

In very small quantities they would undoubtedly be beneficial.

9. Have shells or pounded limestone, or limestone gravel, been strewed upon the soil with a view to their action as a permanent fertilizer?

10. Has limestone or any other rock been ground and used as a manure?

11. Has peat been rotted and tried as a manure?

12. Has pond-hole mud been tried?

13. Have clay soils been dressed with sand, sand soils with clay, and marshes with gravel or sand?

14. Are banks of shells known, except such as have been left by the Indians, and which are either superficial or buried by a small depth of turf, drift sand, or earth washed over them where the water flows?

Caves.

1. Are there caves in the vicinity, and in what kind of rock?

2. Do they appear to have been once fissures, and so symmetrical

on the sides that if brought together, the salient parts of one side would fit into the reentering parts of the other?

3. Are the sides and roof adorned with stalactites of a white, gray, or yellow color, hanging in pendulous masses, like icicles or drapery?

4. Is the bottom of the cave covered with stalagmite, and is it of such a color or transparency and beauty as to be fitted for an ornamental marble?

5. Do streams of water pass through the caves?

6. Do the internal parts show arched passages worn smooth, as if by the action of flowing water?

7. Have bones been found in the earth in the bottom of the cave?

8. Are they similar to those of existing animals?

9. Has the stalagmitic crust (which covers the bone earth in many caves) been penetrated in search of bones?

10. Have remains of human art been found in similar situations?

Are there subterranean streams, land-slips, sink-holes, (formed by the sinking down of small tracts,) rocking stones, natural ice-houses, or curious or interesting natural phenomena of any kind which have come under your observation, and which are not embraced in the preceding queries?

Suggestions for collecting Geological Specimens, and observing Geological Phenomena.

1. Collect specimens of all those rocks, earths, sands, clays, peats, marls, and lignites observed, and note the relative quantities, whether abundant or rare.

2. If any of those materials be applied to useful purposes, note their particular applications, the places where used, the amount of industry and capital employed, and the articles produced.

3. If they be not used, note whether, in your opinion, any one, or all, may be usefully applied, and for what; and what facilities the adjacent country may present for manufacture or transport, or from its contiguity to a market.

4. Note the order of superposition of the different beds of rock, earth, sand, clay, &c., with regard to each other; the amount and direction of the dip; whether dislocations or faults, dykes, veins, &c. traverse the strata, and the direction and inclination of these dislocations, veins, dykes, &c. Sketches should generally be made to illustrate the thickness and relative position of strata, particularly if they be contorted.

5. Note if any traces of organic existence be observable in any of the materials mentioned, whether animal or vegetable, either as impressions, casts, or petrifactions; whether imbedded or loose in these materials.

6. The excavations in mining, quarrying, cutting canals, rail-roads, &c., offer particular facilities for observing the phenomena of stratification, of the superposition of rocks, &c.

7. In Boring for coal, salt springs, &c. it is hoped that specimens of

the rock, clay and sands, of every foot in depth passed through, will be preserved, and accurate minutes made in writing, on the spot.

8. In deep wells, mines and salt springs, the temperature of the water should be measured as it issues from the strata.

9. The temperature of copious springs should be measured, noting if it be different at different seasons of the year.

10. In mines, is there a local variation of the compass, and are there evidences of the passage of electrical currents?

11. What is the mean temperature of the bottom of the mine, and of the rocks at the ends of the levels, at such a depth as to be beyond the influence of the heated air of the mine?

12. Specimens to illustrate the various kinds of minerals, rocks, clays, marls, peats, &c. should generally be about two by three, or three by four inches, and one to two inches thick, of a rectangular form, and free from hammer-marks and weathering.

13. Fossils, or rock specimens containing fossils, must be taken of such a size, as may be necessary to illustrate to the best advantage; still, where fossils are imbedded in stone, much taste may be displayed in getting them out with a good shape, and free from hammer marks.

14. The occurrence of bones, tusks, teeth, shells, &c. where wells, cellars, canals, roads, &c. have caused excavations to be made, should be particularly noted.

15. Every specimen from the same *stratum* at any *one locality*, should be similarly marked.

16. Each specimen should be wrapped securely in a separate paper, and packed tightly in a box, so that it may not be rubbed and injured by transportation from one part of the country to another.

17. It is important that rock specimens and fossil remains should be taken from ledges of rock in their natural position, and not from loose masses.

15. Soils should be taken from a depth of about 8 inches below the surface.

19. The names of the county, township, and land owner, should be distinctly marked on a small label, which should be enclosed in the wrapper of the specimen.

W. W. MATHER,
Principal Geologist of Ohio.

GLOSSARY

OF SOME

GEOLOGICAL TERMS USED IN THESE REPORTS,

FROM

LYELL'S GEOLOGY AND OTHER SOURCES.

No. 7.

Alluvial. The adjective of Alluvium.

Alluvion. A synonim of Alluvium.

Alluvium. Recent deposits of earth, sand, gravel, mud, stones, peat, shell banks, shell marl, drift sand, &c., resulting from causes now in action. This term is generally applied to those deposits in which water is the principal agent.

Alum rocks. Rocks which, by decomposition, form Alum.

Amorphous. Bodies devoid of regular form.

Amygdaloid. A trap rock which is porous and spongy, with rounded cavities scattered through its mass. Agates and simple minerals are often contained in these cavities.

Anthracite. A species of mineral coal, hard, shining, black, and devoid of bitumen.

Anticlinal. An anticlinal ridge or axis is where the strata along a line dip contrariwise, like the sides of the roof of a house.

Arenaceous. Sandy.

Argillaceous. Clayey.

Augite. A simple mineral of variable color, from black through green and gray to white. It is a constituent of many volcanic and trappean rocks, and is also found in some of the granitic rocks.

Avalanche. This term is usually applied to masses of ice and snow which have slidden from the summits or sides of mountains. It is now also applied to slides of earth and clay.

Basalt. One of the common trap rocks. It is composed of Augite and feldspar, is hard, compact, and dark green or black, and has often a regular columnar form. The palisades of the Hudson show the columnar aspect of trap rocks. The Giants' causeway is cited as an example of Basaltic rocks, and the columnar structure is there very strikingly displayed.

Bitumen. Mineral pitch, which is often seen to ooze from fossil coal when on fire.

Bituminous Shale. A slaty rock, containing bitumen, and which occurs in the coal measures.

Blende. Sulphuret of Zinc. A common shining zinc ore.

Bluffs. High banks of earth or rock with a steep front. The term is generally applied to high banks forming the boundaries of a river, or river alluvions.

Botryoidal. Resembling a bunch of grapes in form.

Boulders. Rocks which have been transported from a distance, and more or less rounded by attrition or the action of the weather. They lie upon the surface or loose in the soil, and generally differ from the underlying rock in the neighborhood.

Breccia. A rock composed of angular fragments cemented together by lime or other substances.

Calc Sinter. A German term for depositions of limestone from springs, and waters which contain this mineral in solution.

Calcareous rocks. A term synonimous with limestones.

Calcareous Spar. Crystallized carbonate of lime.

Carbon. The combustible element of coal.

Carbonates. Chemical compounds containing carbonic acid, which is composed of oxygen and carbon.

Carbonic Acid. An acid gaseous compound, incapable of supporting combustion, and deleterious to animal life. It is common in caves and wells, and many incautious persons loose their lives in consequence of descending, without first ascertaining its presence by letting down a lighted candle. Man cannot live where a candle will not burn freely.

Carboniferous. Coal bearing rocks. This term has been applied to a formation belonging to an ancient group of secondary rocks which contains coal. The term is now used in a more enlarged sense, and may be applied to any rocks containing coal.

Chert. A siliceous mineral, approaching to chalcedony, flint and hornstone. It is usually found in limestone.

Chlorite. A soft green scaly mineral, slightly unctuous.

Chloritic Slate. Slate containing chlorite.

Clinkstone. A slaty feldspathic or basaltic rock, which is sonorous when struck.

Clearage. The separation of the laminae of rocks and minerals in certain constant directions. They are not always parallel to the planes of stratification, but are often mistaken for them.

Coal formation. Coal measures. These terms are considered synonimous, and refer to the great deposit of coal in the older secondary rocks, which has been called the "independent coal formation." There are, however, deposits of carbonaceous matter in all the geological periods, and several of them might also be called coal formations.

Conformable. When strata are arranged parallel to each other, like the leaves of a book, they are said to be conformable. Other strata lying across the edges of these may be conformable among themselves, but *unconformable* to the first set of strata.

Conglomerate, or Puddingstone. Rocks composed of rounded masses, pebbles and gravel cemented together by a siliceous, calcareous, or argillaceous cement.

Cretaceous. Belonging to the Chalk formation.

Crop out and out crop. Terms employed by Geologists and Mining Engineers, to express the emergence of rock, in place, on the surface of the earth at the locality where it is said to crop out.

Crystalline. An assemblage of imperfectly defined crystals, like loaf sugar and common white marble.

Delta. Alluvial land formed at the mouths of rivers.

Denudation. A term used to express the bare state of the rocks over which currents of water have formerly swept, and laid the rocks bare, or excavated them to form valleys of denudation.

Deoxidize. To separate oxygen from a body.

Dykes. A kind of vein intersecting the strata, and usually filled with some unstratified igneous rock, such as granite, trap or lava. These materials are supposed to have been injected in a melted state into great rents or fissures in the rocks.

Diluvium and *Diluvion.* Deposits of boulders, pebbles, and gravel which many geologists have supposed were produced by a diluvial wave or deluge sweeping over the surface of the earth.

Dip. Where strata are not horizontal, the direction in which their planes sink or plunge, is called the direction of the dip, and the angle of inclination, the angle of dip.

Dolomite. A magnesian limestone belonging to the primary class. It is usually granular in its structure, and of a friable texture.

Dunes. Sand raised into hills and drifts by the wind.

Earth's Crust. The superficial parts of our planet which are accessible to human observation.

Eocene. The strata deposited during the oldest of the tertiary epochs, as, for example, the Paris Basin.

Estuaries. Inlets of the sea into the land. The tides and fresh water streams mingle and flow into them. They include not only the portion of the sea adjacent to the mouths of rivers, but extend to the limit of tide water on these streams.

Exuviæ. In Geology, fossil remains.

Fault. A dislocation of strata, at which the layers on one side of a dyke or fissure have slidden past the corresponding ones on the other. These dislocations are often accompanied by a dyke. They vary from a few lines to several hundred feet.

Feldspar. One of the simple minerals, and, next to quartz, one of the most abundant in nature.

Ferruginous. Containing iron.

Fluviatile. Belonging to a river.

Formation, A group of rocks which were formed during a particular period, or which are referred to a common origin.

Fossils. The remains of animals and plants found buried in the earth, or enclosed in rocks. Some of these are but slightly changed, others are petrified and the organic replaced by mineral matter; some have decayed and left the impression of the bodies, while others have been formed by mineral matter deposited in the cavities left by the decay of the organic body. These last are called *casts.* The term petrifaction is applied to those cases in which organic matter has been replaced by mineral substances. The form and structure of the original body both remain. In casts the exterior form alone is preserved. Fossils are also called organic remains.

Fossiliferous. Containing organic remains.

Galena. An ore of lead composed of lead and sulphur.

Garnet. A simple mineral, which is usually red and crystallised. It is abundant in most primitive rocks.

Gneiss. A stratified primary rock, composed of the same materials as granite, but the mica is distributed in parallel layers, which give it a striped aspect.

Geology. A science which has for its object to investigate the structure of the earth, the materials of which it is composed, the manner in which these are arranged, with regard to each other; and it considers the action of all natural causes in producing changes, such as the effects of frost, rain, floods, tides, currents, winds, earthquakes and volcanos.

Economical Geology refers to the applications of geological facts and observations to the useful purposes of civilized life.

Granite. An unstratified rock, composed generally of quartz, feldspar and mica, and it is usually associated with the oldest of the stratified rocks.

Graywacke Grauwacke. A group of strata in the transition of rocks; but the term has been so indefinitely applied, that other names will probably be substituted.

Greenstone. A trap rock, composed of hornblend and feldspar.

Grit. A coarse-grained sandstone.

Gypsum. A mineral, composed of sulphuric acid and lime, and extensively used as a stimulant manure, and for making stucco and plaster casts, &c. It is also called Plaster of Paris.

Hornblende. A mineral of a dark green or black color, and which is a constituent part of greenstone.

Hornstone. A siliceous mineral, approaching to flint in its characters.

In Situ. In their original position where they were formed.

Laminae. The thin layers into which strata are divided, but to which they are not always parallel.

Lacustrine. Belonging to a lake. Depositions formed in ancient as well as modern lakes, are called lacustrine deposits.

Landslip. It is the removal of a portion of land down an inclined surface. It is in consequence of the presence of water beneath, which either washes away the support of the superincumbent mass, or so saturates the materials that they become a slippery paste.

Line of Bearing, is the direction of the intersection of the planes of the strata with the plane of the horizon.

Lignite. Wood naturally carbonized and converted into a kind of coal in the earth.

Littoral. Belonging to the shore.

Loam. A mixture of sand and clay.

Mural Escarpment. A Rocky cliff with a face nearly vertical like a wall.

Mammillary. A surface studded with smooth small segments of spheres like the swell of the breasts.

Mammoth. An extinct species of the elephant.

Marl. By this term an argillaceous carbonate of lime is usually implied. By custom, its signification is much more extended, and means mineral substances, which act as stimulating or fertilizing manures. There are clay marls, shell marls, and various others.

Mastodon. A genus of extinct fossil animals allied to the elephant. They are so called from the form of the grinders which have their surfaces covered with conical mammillary crests.

Matrix. The mineral mass in which a simple mineral is imbedded, is called its *matrix* or *gangue*.

Megatherium. A fossil extinct; quadruped resembling a gigantic sloth.

Mechanical origin Rocks of, Rocks composed of sand, pebbles or fragments, are so called, to distinguish them from those of a uniform crystalline texture, which are of chemical origin.

Mica. A simple mineral having a shining silvery surface, and capable

of being split into very thin elastic leaves or scales. The brilliant scales in granite and gneiss are mica.

Mica Slate. One of the stratified rocks belonging to the primary class. It is generally fissile, and is characterized by being composed of mica and quartz, of which the former either predominates, or is disposed in layers, so that its flat surfaces give it the appearance of predominating.

Miocene. One of the deposits of the tertiary epoch. It is more recent than the *eocene*, and older than the pliocene.

Mollusca. Molluscous animals. "Animals, such as shell fish, which, being devoid of bones, have soft bodies."

Mountain Lmestone. "A series of limestone strata, of which the geological position is immediately below the coal measures, and with which they also sometimes alternate."

Muriate of Soda. Common Salt.

Naphtha. A fluid volatile inflamable mineral, which is common in volcanic districts, and in the vicinity of the Salt Springs of the United States.

New Red Sand-stone. "A series of sandy and argillaceous, and often calcareous strata, the prevailing color of which is brick red, but containing portions which are greenish grey. These occur often in spots and stripes, so that the series has sometimes been called, the variegated sandstone. The European, so called, lies in a geological position immediately above the coal measures."

Nodule. A rounded, irregular shaped lump or mass.

Old Red Sand-stone. "A stratified rock, belonging to the carboniferous group of Europe."

Oolite. "A lime-stone, so named, because it is composed of rounded particles like the roe or eggs of fish. The name is also applied to a large group of strata characterized by peculiar fossils."

Organic Remains. See *Fossils.*

Orthoceratite. The remains of an extinct genus of molluscous animals, called Cephalopoda. The orthoceratites are long, straight, conical chambered shells.

Out-crop. See *Crop-out.*

Out-liers. Hills or ranges of rock strata, occurring at some distance from the general mass of the formations to which they belong. Many of these have been caused by denudation, having removed parts of the strata which once connected the out-liers with the main mass of the formation.

Oxide. A combination of oxygen with another body. The term is usually limited to such combinations as do not present active acid or alkiline properties.

Palaeontology. A science which treats of fossil remains.

Pisolite. A calcareous mineral, composed of rounded concretions like peas.

Pliocene. The upper, or more recent tertiary strata. This group of strata is divided into the older and newer pliocene rocks.

Petroleum. A liquid mineral pitch. It is common in the region of salt springs in the United States.

Porphyry. A term applied to every species of unstratified rock, in which detached crystals of feldspar are diffused through a compact base of other mineral composition.

Productus. An extinct genus of fossil bivalve shells.

Plastic Clay. One of the beds of the Eocene period. The plastic clay formation is mostly composed of sands with associate beds of clay.

Pudding Stone. See *Conglomerate.*

Pyrites. A mineral, composed of sulphur and iron. It is usually of a brass yellow, brilliant, often crystalized, and frequently mistaken for gold.

Quartz. A simple mineral, composed of silex. Rock crystal is an example of this mineral.

Rock. All mineral beds, whether of sand, clay, or firmly aggregated masses, are called rocks.

Sand-stone. A rock composed of aggregated grains of sand.

Saurians. Animals belonging to the lizard tribe.

Schist. Slate.

Seams. "Thin layers which separate strata of greater magnitude."

Secondary Strata. "An extensive series of the stratified rocks, which compose the crust of the globe, with certain characters in common, which distinguish them from another series below them, called primary, and another above them, called tertiary."

Sedimentary Rocks—Are those which have been formed by their materials having been thrown down from a state of suspension or solution in water.

Selenite. Crystalized gypsum.

Septaria. Flattened balls of stone, which have been more or less cracked in different directions, and cemented together by mineral matter which fills the fissures.

Serpentine. A rock composed principally of hydrated silicate of magnesia. It is generally an unstratified rock.

Shale. An indurated slaty clay, which is very fissile.

Shell Marl—Fresh water Shell Marl. A deposit of fresh water shells, which have disintegrated into a grey or white pulverulent mass.

Shingle. The loose, water-worn gravel and pebbles on shores and coasts.

Silex. The name of one of the pure earths which is the base of flint, quartz, and most sands and sand-stones.

Silt. "The more comminuted sand, clay and earth, which is transported by running water."

Simple Minerals—Are composed of a single mineral substance. Rocks are generally aggregates of several simple minerals cemented together.

Slate. A rock dividing into thin layers.

Stalactite. Concreted carbonate of lime, hanging from the roofs of caves, and like icicles in form.

Stalagmites. Crusts and irregular shaped masses of concreted carbonate of lime, formed on the floors of caves, by deposits from the dripping of water.

Stratification. An arrangement of rocks in strata.

Strata. Layers of rock parallel to each other.

Stratum. A layer of rocks; one of the strata.

Strike. The direction in which the edges of strata crop out. It is synonimous with *line of bearing.*

Syenite and *Sienite.* A granitic rock, in which hornblende replaces the mica.

Synclinal line and *Synclinal axis.* When the strata dip downward in opposite directions, like the sides of a gutter.

Talus. In geology, a sloping heap of broken rocks and stones at the foot of many cliffs.

Tertiary Strata. "A series of sedimentary rocks, with characters which distinguish them from two other great series of strata—the secondary and primary—which lie beneath them."

Testacea. "Molluscous animals, having a shelly covering."

Tepid. Warm.

Thermal. Hot.

Thin out. Strata which diminish in thickness until they disappear, are aid to *thin out.*

Trap—Trappean Rocks. Ancient volcanic rocks, composed of feldspar, hornblende and augite. Basalt, greenstone, amygdaloid and dolerite, are trap rocks.

Travertin. "A concretionary lime-stone, hard and semi-crystalline, deposited from the water of springs."

Tufa Calcareous. "A porous rock, deposited by calcareous waters on exposure to air, and usually containing portions of plants and other organic substances incrusted with carbonate of lime."

Tufaceous. A texture of rock like that of tuff.

Tuff or *Tufa.* "An Italian name for a volcanic rock of an earthy texture."

Unconformable. See conformable.

Veins. Cracks and fissures in rocks filled with stony or metallic matter. Most of the ores are obtained from metallic veins.

Zoophytes. Coral sponges and other aquatic animals allied to them.

SECOND ANNUAL REPORT

ON THE

GEOLOGICAL SURVEY

OF THE

STATE OF OHIO.

BY W. W. MATHER,
PRINCIPAL GEOLOGIST, AND THE SEVERAL ASSISTANTS.

COLUMBUS:
SAMUEL MEDARY, PRINTER TO THE STATE.
1838.

EXECUTIVE OFFICE, OHIO,
COLUMBUS, *December* 18, 1838.

To the General Assembly of the State of Ohio:

I have received, and herewith transmit to you, the Report of W. W. MATHER, principal Geologist, and the reports of C. Whittlesey, Esq., Col. J. W. Foster, C. Briggs, Jr., and Prof. J. P. Kirtland, his assistants. The report of Prof. John Locke has not yet been received, but is expected in a few days. When received, it shall be transmitted. Having but one copy of the several reports they are transmitted to the House of Representatives.

WILSON SHANNON.

SECOND ANNUAL REPORT

ON THE

GEOLOGICAL SURVEY OF OHIO.

By W. W. MATHER, Principal Geologist.

To his Excellency WILSON SHANNON:

Sir:—Since the 1st report of the Geological survey of the State, the work has been progressing as rapidly as the means at our disposal have rendered practicable, and the results, it is believed, of this year's labor, are such as to have excited much local interest where the survey has been in progress, by developments of beds of valuable minerals, and by leading our citizens to appreciate more fully the mineral wealth, as well as the agricultural value of the soil. The field labors of two of the gentlemen engaged on the survey were discontinued with their own consent, in consequence of the unexpended balance of the appropriation of 1836, being to small to keep all the members of the Geological Board in the field through the working season.

During the first year of the survey, much time was necessarily consumed in making preparation for the work, and procuring the various materials which were necessary to its advancement: but during the past season, although laboring under many disadvantages for want of funds to carry on the survey as rapidly and as efficiently as was desired, the progress is believed to be such as to satisfy all, that it can be completed for the sum mentioned in my estimates, viz: 50,000 dollars.

The counties examined the past season are Adams, Butler, Crawford, Wood, Tuscarawas, Hocking, Athens, Licking, Muskingum, Trumbull and Portage.

An impression has extensively prevailed that no part of the State would be benefited by the Geological Survey, except the coal and iron region.

With a view to set this matter in a proper light, the geologists were directed to make surveys of some counties, which were not expected to reap any benefit from the survey. The result is that which was expected, viz: the development of marl, clay, peat, limestone, &c. adapted to various useful purposes, such as for manures, lime, hydrau-

lic lime, building stone, and marble. Our rocky hills and lands, where they exist, are yet looked upon as useless and valueless property, instead of repositories of useful materials, which present or future enterprise is to convert into substantial wealth. The rocky ledges on some parts of the Lake coast, and those at Waverly and Portsmouth are beginning to be appreciated. The sandstones of Cleveland are largely quarried and shipped to various parts both within and without the State; some for columns and building stone, and some for grindstones. The limestone of the N. W. part of the State is also shipped from some parts of the coast and its islands. The sandstones of Portsmouth are sent to various portions of the country below, where good building materials are rare, and large quantities are sent up the Licking river in Kentucky, to construct the locks and dams for the improvements in the navigation of that river. A good quarry on the banks of the Ohio, or of the canal, ought to be as valuable as a coal bed;—but our people do not *realize* this, and it may be long before the fact will be brought *home* to them.

Who shall pretend to calculate the future wealth to be produced by the *lime* made on the banks of the Ohio, and of the canal, for the supply not only of our own population, but the valley of the Mississippi. It has been too much the case, that our rocks have been looked upon as so much *worthless stone*. There was nothing made in vain, and all things will be usefully employed in their proper time. The geological survey will, it is believed, have a tendency to *make known* our mineral wealth, a kind of property that is not suitably understood or appreciated, and the rise of property in value, consequent upon such knowledge has already commenced, and must go on. The chances are now altogether in favor of the *purchaser* of real estate. The seller disposes of his lands for the agricultural value of the soil, while the mineral wealth may be worth ten or a hundred times more. As a general rule, the agricultural value of land is inversely proportioned to its mineral wealth. Many of our School lands have been sold for a small fraction of their value, because they were appraised merely from the agricultural value of the soil, while the standard of value was considered to be the best bottom lands, at the Government price of $1,25 per acre.

RECONNOISANCE.

During the past season I have made slight examinations, which were intended to be preliminary to a more detailed survey. The counties in which these preliminary examinations were made are, Madison, Clark, Champaign, Franklin, Ross, Pike, Highland, Fairfield, Hocking, Athens, Meigs, Gallia, Lawrence, Scioto, Jackson, Licking, Muskingum, Coshocton, Tuscarawas, Stark, Portage, Medina, and Cuyahoga. Before the last session I had made preliminary examinations in Washington, Morgan, Guernsey, Belmont, Trumbull, Ashtabula, Geauga, Huron, Wayne, Holmes, Richland, Knox, Delaware

Marion, Crawford, Seneca, Sandusky, Greene, Warren, Clermont, Hamilton, and Brown, together with some parts of those mentioned as slightly examined this year.

These examinations have laid open to me the general geology of the State, and enabled me to trace out the approximative boundaries of our formations. We may throw the rock formations into three main groupes, viz: the coal, the slate, and the limestone formations; and they are superposed in the order mentioned.

The geological reconnoisance which I made of Kentucky last spring, has enabled me to study the continuation of our formations, where I had not before been favored with opportunities of making observations. The coal formation of Ohio has its western and northern boundary along an irregular line drawn nearly east and west through the northern part of Trumbull county; thence south westerly, across Portage county; east of Akron, across a small corner of Medina, to include about one quarter of Wayne, one half of Holmes, three-fourths of Coshocton, near the northwest corner of Muskingum; thence south, to a little east of Logan; thence south southwest, to Jackson C. H. and to near the mouth of the Little Scioto. The boundary continues thence south-westerly to the mouth of the south forks of the Kentucky and of the Cumberland rivers, and thence continues into Tennessee, beyond the line of which I have not traced it. From the point on the north, in Ohio, where I have indicated the line, the northern boundary sweeps on to the eastward in Pennsylvania, to the Alleghany; thence southwardly, by Cumberland, in Maryland, on until it probably joins the line first traced in Tennessee or Alabama. This coal formation has an area of about fifty thousand square miles, and forms a part of at least six States, viz: eastern Ohio and Kentucky, northeast Tennessee and western Virginia, Maryland, and Pennsylvania. It is in the basin form, the rocky strata all dipping towards its centre, viz: the strata in Ohio dip to the south and south-east and east; those of Kentucky to the east and south-east; those of Pennsylvania to the south, south-west, and west, and those of Virginia and Maryland to the westward.

This coal formation is entirely separated from that which occupies a part of Indiana and western Kentucky, in the valleys of the Wabash and Green rivers, and in this formation, the strata again dip inwards towards the centre of the basin.

Although coal is not *everywhere* easily accessible in the coal region of Ohio, it is found in the greatest abundance, and is easily worked, in a great number of places. The estimate of the coal of Ohio last year, was intentionally placed at the lowest calculation, viz: a mean thickness of six feet, in order that too exalted ideas of the amount of coal under our soil should not be entertained. The investigations and measurements of the past season, justify the conclusion, that in some of the counties there is a thickness of twenty to thirty feet of workable coal. If the before mentioned estimate, showed that Ohio possessed coal enough for every contemplated increase of population and manufactures for twenty-five hundred years, we may now feel that there is

not only sufficient for domestic use for any reasonable time, but to supply the country around the lakes, and throughout the valleys of the Ohio and Mississippi, for as long a time as it is proper to calculate.

Many of the coal beds of Hocking and Athens counties lie *very* convenient to the canal; they are easily worked, and much of the coal is very pure. Dr. Hildreth, who has done more than any other individual to develop the local, as well as the general geology of the State, has described some of these beds. Others have since been opened, and many more will, undoubtedly, be worked ere long, when the canal shall offer an easy mode of transport.

The coal, in the Muskingum valley, is of easy access and abundant, and many of the beds are of a fine quality. The improvements in the navigation of that river, will soon afford an easy exit for our coal.

The coal beds of the south and middle forks of Salt creek are also important.

This coal is of a superior quality; and, it is believed, that few years will be allowed to elapse before a slack water navigation, or a canal, will be authorized by the State up this stream into the heart of the rich coal, iron, and buhr stone region near Jackson C. H.

The project of a canal up the Raccoon creek has been already under discussion before the State Legislature. This stream flows through a region rich in coal, buhr stone, and iron ore: and these natural products must, sooner or later, cause the construction of means of conveyance for these materials to their proper markets. The same remarks apply to Symmes' and Leading creeks, where coal abounds. Coal is so abundant in these regions, that it is considered of little value. It was so at Pittsburgh a few years ago; but now, when the demand for it, for manufactories and domestic use, has increased beyond all their calculations, the value of coal land has risen enormously: so it must be in Ohio, where they are favorably situated for transport or consumption. Some coal lands on the banks of the Ohio, where they were very favorably situated for working, have already sold at $600 per acre, and they have well repaid the outlay.

The Tuscarawas coal and iron ore, have been long known and extensively worked. The investigations of the past season, have shewn the coal and iron ore to be more abundant and extensively diffused than was before known. The details will be found in Prof. Briggs' report.

The coal of Portage county was supposed, until the investigations of the last season, to be confined to a hill about two miles long and one broad. It is now ascertained to be much more extensive than was imagined, and some beds will undoubtedly be soon worked. The Erie and Ohio, the Ohio and Pennsylvania canals, and the numerous thriving and manufacturing villages, are rapidly increasing the value of coal property, by affording additional facilities for transport and increased consumption.

The coal formation of Stark, Trumbull, Columbiana, Coshocton, &c. counties, has not yet been investigated by the Geological board, but it is well known that deposits of fine coal exist there, and several beds have been opened and are extensively worked for the Lake market.

The coal of the country along the upper part of the Ohio river, has not yet been brought under investigation by the Geological board. It is, however, known to be abundant and of an excellent quality.

In reference to the coal, salt and iron of Muskingum county, Mr. Foster, the acting assistant for Muskingum and Licking counties, makes the following remarks in an abstract report to the Canal Commissioners:

"Zanesville, *August* 8, 1838.

"Gentlemen:—Having been requested to make out an abstract of the mineral wealth of this county, I proceed to lay before you the result of my observations. The minerals which will prove the most valuable in an economical point of view, are coal, iron ore and salt, on each of which I propose to offer a few remarks.

"*Coal.*—In order to form a proper idea of the amount of coal, it may be stated that there are no less than six workable beds running through the county in a N. E. and S. W. direction, so as to intersect the river at different points. Four of these beds extend nearly 30 miles through the county, and two extend about 15 miles. As the dip is very slight, varying between 30 and 40 feet per mile—the average breadth may be estimated at 8 miles. In this estimate only those beds which are accessible without sinking shafts, are included, that is, from where they first rise above the water courses, to where they form the caps of the hills; consequently, this estimate includes but a small amount of the coal in the county, which can be readily obtained by sinking shafts, whenever the wants of the community shall require it. We have, then, an area underlain by coal, equal to 120 square miles. We will suppose, however, that by reason of the denudation of the strata, it is capable of exploration only over one half of this area. The aggregate thickness of these six beds may be estimated at 18 feet or 6 yards. Thus the available coal in Muskingum county will amount to 359,712,000 cubic yards. One cubic yard is very nearly equal to a ton of coal. Admitting a profit of only 25 cents on every ton, it would amount to $89,928,000. Every square mile is amply sufficient to supply the amount of fuel annually consumed in Ohio. Thus, it is evident that the county of Muskingum is abundantly supplied with this valuable combustible; and if the time ever arrives, when that above the water courses shall become exhausted, an additional quantity can be procured at an inconsiderable expense, by sinking shafts. As these beds constitute the western limit of the Ohio coal field—there being but one bed below, and that of an inferior quality—the day is not far distant when coal will form an important item of export. From the bulkiness of the article, the best method of transportation is to load it into barges capable of containing 5000 or 6000 bushels and tow them to the place of destination without transhipment.

"*Iron Ores.*—That portion of the county lying west of the Muskingum river is capable of supporting a number of furnaces. There are four beds of iron ore of sufficient thickness to be wrought. They are rich, yielding probably from 30 to 60 per cent of iron—easily wrought, and

producing a soft tenacious iron. I estimate the amount of workable iron ore, in round numbers, at 153,600,000 cubic yards, which, when smelted, will yield about that number of tons in pigs. In connexion with the iron ore, occur limestone for fluxing and coal for smelting, so that there is every facility for its manufacture.

"*Salt.*—The salines of this county are probably the best in the State, with the exception of those on the Hocking. No less than 50 wells have already been bored. Salt water can be obtained of a sufficient strength, and in sufficient quantities to justify the investment of a large capital. To show the strength of the different salines in America, permit me to lay before you the following table, compiled with great care, by Dr. Beck, of New York:

"At Nantucket,	1 bushel	of salt	is made	from	350	gallons.
" Boon's Lick, (Mo.)	"	"	"		450	"
" Conemaugh, (Pa.)	"	"	"		300	"
" Shawneetown, (Il.)	"	"	"		280	"
" Scioto Licks, (Jack'n O.)	"	"	"		213	"
" Lockhart's, (Miss.)	"	"	"		180	"
" Shawneetown, (2 saline)	"	"	"		123	"
" St. Catharine's, (V. C.)	"	"	"		120	"
" Zanesville,	"	"	"	"	95	"
" Muskingum,	"	"	"	"	90	"
" Kenawha, (Va.)	"	"	"		75	"
" Grand River, (Arkan.)	"	"	"		60	"
" Onondagua, (N. Y.)	"	"	"		45	"

"Thus it will be seen that the Muskingum Salines yield the greatest per cent. of salt with the exception of Onondagua, Kenawha and Grand River. But when we take into consideration the greater facilities for its manufacture, which we possess, in the abundance of coal, we have every reason to believe that this branch of industry is yet in its infancy.

"The manufacturing industry of Great Britain, great as it is, rests principally on her mineral wealth, her coal and her iron ore—when they become exhausted, her prosperity will melt away, and her population decrease at least two-thirds. The mineral riches of this county have been but partly explored, and still less appreciated. They are capable of supporting a dense manufacturing population; and to calculate the period of their exhaustion, would be to extend our views for centuries into the future.

"Respectfully yours,

"J. W. FOSTER,

"*Assistant Geologist of Ohio.*"

The Licking coal and buhr stone, have been described by Dr. Hildreth in 1835, 36, and 1837, in the reconnoissance of that part of the state. The detailed investigations were committed to Col. Foster, during the last summer, and the results will be found in his report, which is annexed. The resources of this county, in valuable minerals, and materials for construction and other purposes, are greater than

was anticipated. Cannel coal, buhr stone, limestone, iron ore and freestone, are among the most valuable of her mineral products.

In the coal formation of Ohio, the materials for the manufacture of glass are abundant, and in hundreds of places, all the facilities for its manufacture are conbined. These are, 1st fuel, (either coal or wood, at the option of the manufacturer) 2d, silicious sandstone; 3d, potassa, ashes, and salt; 4th, water transport to a market; 5th, fire clay. The sandstone, of various qualities, may be found in the hills. It is adapted, not only for the use just mentioned, but for whetstones, grind stones, furnace hearths, for which it might be sent to various parts of the valley of the Mississippi. It has been and is still quarried extensively for buildings, bridges, locks, dams, aqueducts, and other purposes, in the river hills of the Ohio, and on our principal river valleys and along the canals.

The manufacture of iron has already become an important branch of industry in Ohio. It is now almost entirely made of the charcoal of hard wood, which is abundant and cheap. The demand for iron, however, is such as to render it an object, to make large quantities of this metal for particular purposes, at a cheaper rate, viz: with coke or the charcoal of bituminous coal. This material is inexhaustible, and in many places of fine quality for the manufacture of iron through most of the iron region of the state. The demands of the country will not long permit this branch of industry, so important to the future prosperity of this section of our country, to slumber; and I conceive that it is for the interest of the State to foster it, and give it every encouragement. The influence exerted upon Great Britain, in every ramification of business, by the iron trade of South Wales, since the introduction of coke, is well known, and it is not doubted, that in this country, the same kind of industry will be of equal importance, before one fourth of a century shall have elapsed.*

In my first annual report to this legislature, I mentioned that coke was beginning to be used in three of our furnaces. Whether it has increased during the past season, I have not been informed; but it is now extensively used for melting iron for castings. Anthracite was formerly brought to various parts of this State from Pennsylvania, at a great expense, for this purpose; but in consequence of the great expense, coke has been substituted, and is equally effective. One ton of coke will melt from five to ten tons of iron. Seven tons is considered an average. This variation is due to the greater or less purity of the coal. The coal may be used raw in the furnace where it cokes itself, or it may be previously coked in a coke oven, or in a heap in the open air. By coking it loses about one half its weight, but increases about one fourth in bulk. (Vide appendix.)

The amount of the consumption of the coal, iron and lime of the Ohio and Mississippi Valleys, is constantly increasing, and must con-

* England now manufactures more than 1,000,000 tons of iron per annum from the ore, and it is almost entirely made from the iron stone of the coal formation, and smelted with coke made from bituminous coal.

tinue to do so, in consequence of the increase of population and manuacturing industry, and the new uses to which they are applied. The geological surveys are now making known the general boundaries of our mineral deposits, and we know where not only our present wants are to be supplied, but those of succeeding ages. The impression is too common among our citizens, that as coal and limestone occur on the upper and lower Ohio, in several places, and on the Mississippi above the Ohio, that these useful substances are common over the whole western country. This is far from being the case. The lower Mississippi Valley is to be supplied with coal from the coal regions of the upper Ohio river in Ohio, Kentucky, Virginia, and Pennsylvania; from the lower Ohio coal basin in the valleys of the Green and Wabash rivers; and from the coal formation of Illinois and Missouri. These coal basins embrace, it is believed, all the accesssible coal of the valley of the Mississippi, except the coal formation far up the Arkansas river in the west part of Arkansas, and the Indian country west of it.

A few years will undoubtedly show our steam boats propelled entirely by this combustible. Many of our boats now use coal in preference to the best wood for a double reason, (viz.) that the fire can be kept more uniform and generate a great quantity of steam; 2d, that the expense is much less. Ten to twelve bushels of coal produce the same power as a cord of the best wood. The space occupied by equivalent quantities of coal and wood is said to be about one to nine, and the weight about one to three, and the labor of putting on board our boats, about one to four.

The price of coal on the Ohio river varies at different points, from five to sixteen cents per bushel. The average is probably about ten cents per bushel. The average price of wood on the Ohio, is about $2 50 per cord. It is now generally admitted that coal at 25 cents per bushel is equivalent to wood at $2 50 per cord, while it has but one third the weight, and occupies only one ninth the bulk. The advantage, therefore, to steam boats where weight, bulk and time, are valuable, is sufficiently manifest. The coal now used within this State, on the banks of the Ohio, is estimated to be about two millions of bushels per annum, and about as much more is supposed to be consumed in the interior of the State, at the average price of ten cents per bushel. The amount of coal sent by canal to Cleveland annually, part of which is there consumed, and part shipped to various ports around the lake in New York, Pennsylvania, Ohio, Michigan and Canada, is supposed to amount to about one million of bushels. This branch of industry must now give employment to at least one thousand men as miners, boatmen, &c., of Ohio, most of whom are heads of families, and the value produced is at least $500,000, per annum.

The analysis of the coals, iron ores, &c. of Ohio was commenced last year, after expending much time, labor and money in procuring the various means and conveniences necessary in a chemical laboratory, for the analysis of the various mineral substances of the State. The results of some of the analyses are given below.

ANALYSES OF THREE COALS, AND PARTIAL ANALYSES OF FOUR OTHERS.

	D. Upson's Coal, Tallmadge, Portage co., O. By W. W. Mather.	Howe's coal, Lick township, Jackson co., O. By W. W. Mather.	Madison township, Jackson co., O. By Prof. J. L. Cassels.	Cannel coal, Bundren's mine, sec. 15, T. 7, R. 18, Jackson co., O.	Cannel coal, Flint Ridge, Licking co., O. By W. R. Guest.	Brownsville coke from Pennsylvania.	Elk towns'p, Athens co., O.	Coal Grove.
Specific gravity	1.264	1.283	1.56	1.41	1.299	-	1.291	
Hygrometric water	5.067	5.245	6.10	8.	0.82	-	9.64	
Bitumen, - 39.231 } Volatilized sulphur 0.274 }	39.505	42.215	38.70	37.	47.67			
Coke, containing earthy matter and protosulphuret of iron	55.425	51.970	55.20	55.	51.48			
Total	99.997	99.430	100.00	100.	99.97			
Composition of the cokes of the above.								
Carbon	96.355	94.38		63.75	80.1	77.66		
Protosulphuret iron	1.375	0.70		} 37.40	19.13	22.34		
Earthy matter of coke	2.270	3.32						
Hygrometric water in second		1.33						
Total	100.000	99.73		101.15	99.23	100.00		
Composition of the coals.								
Hygrometric water	5.067	5.245	6.10					
Bitumen	39.231	42.082	38.70					
Bisulphuret of iron	1.030	0.496	12.99					
Carbon	53.404	49.882	39.95					
Earthy matter	1.258	1.725	1.63					5.80	8.25
Total	99.990	99.430	99.37					

In my last report, the subject of soils as connected with geology was slightly discussed. Since that time, some important facts in relation to manures and the action of lime, acids and iron upon soils, have been made public in the report of the geological resurvey of Massachusetts. These are of so much practical utility, that I have deemed it proper, without excuse, to introduce the results into this report, in order that our citizens may equally receive benefit from the investigations of science.

"All geologists and chemists agree in regarding soils as the result of the abrasion, disintegration, and decomposition of rocks, with the addition of certain saline, vegetable, and animal substances. Ever since the deposition of rocks, various agents have been operating upon them to wear them down, to cause them to crumble or disintegrate, and often to decompose them into their proximate or ultimate principles, while they have been constantly receiving vegetable and animal substances with soluble salts. The earthy portions, however, always constitute by far the largest part; and hence, if we know the composition of the rocks whence they were derived, we shall know the earthy and metallic constiuents of the soil. Now we find that nearly all the rocks which exist in large quantity, are composed chiefly of silica, alumina, lime and oxide of iron : and these are the ingredients that are found almost invariably in soils.

"With common alluvial soils—the result of deposition from rivers,—every intelligent man is familiar. They are of course formed by the comminution of every kind of rock over which the stream that produces them happens to pass. These soils, I apprehend, owe their value chiefly to the fine state to which their component parts are reduced. They may be made so fine as to exclude too much the access of the air : and this seems to be the case with some of the soils upon our large rivers at the west.

"Peat alluvium is composed principally of vegetable matter, and ought rather to be regarded as a manure than a soil. I include in it all those swamps that abound in decomposing vegetable matter, whether actually converted into peat or not.

"Till within a few years past, the state in which vegetable and animal matter exists in the soil, and the changes through which it passes, before being taken up by the roots of the plant, were almost entirely unknown to Chemists. Long ago, however, Klaproth had discovered a peculiar substance in the elm tree, which he denominated *ulmin*. More recently it was found by Braconnot in starch, saw-dust, and sugar; and by the distinguished Sweedish chemist, Berzelius, in all kinds of herbs. Sprengel and Polydore Boullay have ascertained, also, that it constitutes a leading principle in manures and soils. Hence they called it *Humin* ; but Berzelius adopts the name of *Geine*. When wet, it is a gelatinous mass, which, on drying, becomes of a deep brown or almost black color, without taste or smell, and insoluble in water ; and, therefore, in this state incapable of being absorbed by the roots of plants. Yet, after the action of alkalis upon it, it assumes the character of an acid, and unites with ammonia, potassa, lime,

alumina, &c., and forms a class of bodies called *Geates*, most of which are soluble in water, and, therefore, capable of being taken up by plants. And it is in the state of *Geates*, that this substance for the most part exits in the soil.

"It is but justice to say, that Dr. Dana derived his knowledge of geine chiefly from his own researches, made with a view to improve the coloring processes in the Calico Printing Establishment, at Lowell; and his method of analysing soils is altogether original. The statements of Berzelius, indeed, though interesting in a theoretical point of view, afford very little light to the practical agriculturist. Those of Dr. Dana appear to me to be far more important in a scientific, as well as practical point of view; although essentially coinciding with those European chemists, so far as they have gone. His method of analysis, derived from his researches, I must say, after having made extensive application of it to our soils, is simple and elegant, and taken in connection with his preliminary remarks, it appears to me to be a most important contribution to agricutural chemistry, and promises much for the advancement of practical agriculture. I trust it will be favorably received by the government, and by all intelligent men, who take an interest in the subject. His preliminary remarks and rules, I shall now present in his own language.

"'By *geine*,' says he, 'I mean all the decomposed organic matter of the soil. It results chiefly from vegetable decomposition; animal substances produce a similar compound containing azote. There may be undecomposed vegetable fibre so minutely divided, as to pass through the sieve; (see first step in the rules for analysis); but as one object of this operation is to free the soil from vegetable fibre, the portion will be quite inconsiderable. It can affect only the amount of insoluble geine. When so minutely divided, it will probably pass into geine in a season's cultivation. Geine exists in two states: soluble and insoluble: soluble both in water and in alkali, in alcohol and acids. The immediate result of recent decomposition of vegetable fibre is abundantly soluble in water. It is what is called solution of vegetable extract. Air converts this soluble into *solid* geine, *still partially soluble in water*, wholly soluble in alkali. Insoluble geine is the result of the decomposition of solid geine; but this insoluble geine, by the long continued action of air and moisture, is again so altered as to become soluble. It is speedily converted, by the action of lime, into soluble geine. Soluble geine acts neither as acid nor alkali. *It is converted into a substance having acid properties by the action of alkali*, and in this state combines with earths, alkalies, and oxides, forming neutral salts, which may be termed *geates*. These all are more soluble in water than solid geine; especially when they are first formed. Their solubility in cold water is as follows: beginning with the easiest, magnesia—lime—manganese—peroxide of iron—(it does not unite with the protoxide of iron) alumina—baryta. The geates of the alkaline earths are decomposed by carbonated alkali. The geates of alumina and of metallic oxides, are soluble in caustic or carbonated alkali without decomposition. The geates of the alkaline earths, by the action of the carbonic

acid of the air, become *super-geates*, always more soluble than neutral salts. Soluble geine, therefore, includes the watery solution—the solid extract caused by the action of air on the solution, and the combinations of this with alkalies, earths and oxides. Insoluble geine includes all the other forms of this substance."

"Soluble geine is the food of plants. Insoluble geine becomes food by air and moisture. Hence the reason and result of tillage. Hence the reason of employing pearlash to separate soluble and insoluble geine in analysis."

"These are the facts. Will they not lead us to a rational account of the use of lime, clay, ashes and spent ley? Will they not account for the superiority of unfermented over fermented dung, in some cases?"

"Geine forms the basis of all the nourishing part of all vegetable manures. The relations of soils to heat and moisture, depend chiefly on geine. It is in fact, under its three states of vegetable extract, geine, and carbonaceous mould, the principle which gives fertility to soils long after the action of common manures has ceased. In these three states it is essentially the same. The experiments of Saussure have long ago proved that air and moisture convert insoluble into soluble geine. Of all the problems to be solved by agricultural chemistry, none is of so great practical importance, as the determination of the quantity of soluble and insoluble geine in soils. This is a question of much higher importance than the nature and proportions of the earthy constituents and soluble salts of soils. It lies at the foundation of all successful cultivation. Its importance has been not so much overlooked as undervalued. Hence, on this point the least light has been reflected from the labors of Davy and Chaptal. It needs but a glance at any analysis of soils, published in the books, to see that fertility depends not on the proportion of the earthly ingredients. Among the few facts, best established in chemical agriculture, are these: that a soil, whose earthy part is composed wholly, or chiefly, of one earth; or, any soil, with excess of salts, is always barren; and that plants grow equally well in all soils, destitute of *geine*, up to the period of fructification,—failing of geine, the fruit fails, the plants die. Earths, and salts, and geine, constitute, then, all that is essential; and soils will be fertile, in proportion as the last is mixed with the first. The earths are the plates, the salts the seasoning, the geine the food of plants. The salts can be varied but very little in their proportions, without injury. The earths admit of wide variety in their nature and proportions.

"When we look at the analysis of vegetables, we find these inorganic principles constant constituents—silica, lime, magnesia, oxide of iron, potash, soda, and sulphuric and phosphoric acids. Hence these will be found constituents of all soils. The phosphats have been overlooked from the known difficulty of detecting phosphoric acid. Phosphate of lime is so easily soluble when combined with mucilage of gelatine, that it is among the first principles of soils exhausted.—Doubtless the good effects, the lasting effects of bone manure, depend

more on the phosphat of lime, than on its animal portion. Though the same plants growing in different soils are found to yield variable quantities of the *salts* and earthy compounds; yet I believe, that accurate analysis will show, that similar parts of the same species, at the same age, always contain the inorganic principles above named."

"These inorganic substances will be found not only in constant quantity, but always in definite proportion to the vegetable portion of each plant. The effect of cultivation may depend, therefore, much more on the introduction of *salts* than has been generally supposed. The *salts* introduce new breeds. So long as the salts and earths exist in the soil, so long will they form voltaic batteries with the roots of growing plants; by which, the materials of the soil are decomposed, and the nacent earths, in this state readily soluble, are taken up by the absorbents of the roots, always a living, never a mechanical operation. Hence, so long as the soil is undecomposed, so long is it as good as on the day of its decomposition; *salts* and *geine* may vary, and must be modified by cultivation. The fertile character of soils, I presume, will not be found dependent on any particular rock formation on which it reposes. This is so true, that on this point the farmer already knows all that chemistry can teach him. Clay and sand, every one knows: a soil too sandy, or too clayey, may be modified by mixture, but the best possible mixture does not give fertility. That depends on salts and geine. If these views are correct, the few properties of geine which I have mentioned, will lead us at once to a simple and accurate mode of analysing soils, a mode, which determines at once the value of a soil, from its quantity of soluble and insoluble vegetable nutriments,— a mode, requiring no array of apparatus, nor delicate experimental tact,—one, which the farmer may apply with very great accuracy; and, with a little modification, perfectly within the reach of any man who can drive a team or hold a plough.

"RULES OF ANALYSIS.

1. "Sift the soil through a fine sieve. Take the fine part; *bake* it just up to browning paper.

2. "Boil 100 grains of the baked soil, with 50 grains of pearl ashes, saleratus or carbonate of soda, in 4 ounces of water, for half an hour; let it settle; decant the clear; wash the grounds with four ounces boiling water; throw all on a weighed filter, previously dried at the same temperature as was the soil, (1) wash till colorless water returns. Mix all these liquors. It is a brown colored solution of all the soluble geine. All sulphats have been converted into carbonates, and with any phosphats, are on the filter. Dry, therefore, that, with its contents, at the same heat as before. Weigh—the loss is *soluble geine*.

3. "If you wish to examine the geine, precipitate the alkaline solution with excess of lime-water. The *geate* of lime will rapidly subside, and if lime-water enough has been added, the nitrous liquor will be colorless. Collect the geate of lime on a filter; wash with a little acetic or very dilute muriatic acid, and you have geine quite pure. Dry and weigh.

4. "Replace on a funnel the filter (2) and its earthy contents; wash with two drams muriatic acid, diluted with three times its bulk of cold water. Wash till tasteless. The carbonate and phosphate of lime will be dissolved with a little iron, which has resulted from the decomposition of any salts of iron, beside a little oxide of iron. The alumina will be scarcely touched. We may estimate all as *salts* of lime. Evaporate the muriatic solution to dryness, weigh and dissolve in boiling water. The insoluble will be *phosphat of lime*. Weigh—the loss is the *sulphate of lime;* (I make no allowance here for the difference in atomic weights of the acids, as the result is of no consequence in this analysis.)

5. "The earthy residuum, if of a greyish white color, contains no insoluble geine—test it by burning a weighed small quantity on a hot shovel—if the odor of burning peat is given off, the presence of insoluble geine is indicated. If so, *calcine* the earthy residuum and its filter—the loss of weight will give the insoluble geine; that part which air and moisture, time and lime, will convert into soluble vegetable food. Any error here will be due to the loss of water in a hydrate, if one be present, but these exist in too small quantities in granitic sand, to affect the result. The actual weight of the residuary mass is granitic sand.

"The clay, mica, quartz, &c. are easily distinguished. If your soil is calcareous, which may be easily tested by acids; then before proceeding to this analysis, boil 100 grains in a pint of water, filter and and dry as before, the loss of weight is due to the *sulphate of lime*, even the sulphate of iron may be so considered; for the ultimate result in cultivation is to convert this into sulphate of lime.

"Test the soil with muriatic acid, and having thus removed the lime, proceed as before, to determine the geine and insoluble vegetable matter." *

The alluvial bottoms along our rivers and creeks, are almost annually inundated, and thus naturally manured by a deposit of mud containing more or less organic matter, mixed with some of the salts of lime, and which, from their minute division and chemical composition, are in a fit state to be absorbed by the fibrous rootlets of plants, and serve as food for them. The quantity of organic matter in a soil, ought to correspond with the sum of the quantities of soluble and insoluble geine. Sulphate of lime or gypsum, and phosphate of lime, or the earth of bones, are supposed to be natural constituents of all soils, but vary in proportion. The latter seems indispensable to the continued production of good crops, and is one of the most fertilizing of all manures. Ground bones, the refuse animal charcoal of the sugar refiners, and horn shavings and bone dust from comb factories, are highly prized in Europe and the eastern States. Their effects are truly wonderful, and although our soils are as yet scarcely beginning to be exhausted by cropping, the time cannot be far distant, when our farmers will avail themselves of such aids as have been mentioned. Europe

*Prof. Hitchcock's Geological resurvey of Massachusetts, pages 9, 35.

and Africa send wheat to our eastern markets, and at the same time send out orders for our refuse bones, bone earth of sugar refiners, comb factories, &c.

Many of the bones of the battle ground of Waterloo, and from the bone caves of Germany and Italy, have been transported to England and France to supply a material which has become deficient in their soils.

"When we consider that the bones of all granivorous animals contain nearly 50 per cent of phosphate of lime, we might be at liberty to infer the existence of this principle, in the food, and consequently in the soil on which these animals graze. If we look at the actual result of the analysis of beets, carrots, beans, peas, potatoes, asparagus and cabbage, we find phosphate of lime, magnesia and potash, varying from 0.04 to 1.00 per cent. of the vegetable. Indian corn too, by the analysis of the late Professor Gorham, of Harvard College, contains 1.5 per cent., phosphate and sulphate of lime. It may be said that this is all derived from the manure. We shall see by and by. Let us look at the extensive crops often raised, where man has never manured. Rice, wheat, barley, rye and oats, all contain notable portions of phosphate of lime, not only in the grain but in the straw, and often in the state of superphosphats. The *diseases* too, *ergot* and *smut*, show *free phosphoric acid*. Can it be, that, owing to certain electrical influences of the air, in particular seasons, lime is not secreted by the plant to neutralize the free acid? May not this be a cause of smut and ergot? Does it not point out a remedy? Take too the cotton crop of our country. What vast quantities of phosphats do we thus annually draw from the soil? Cotton gives one per cent. ashes, of which 17 per cent. is composed of phosphate of lime and magnesia. The like is true of tobacco. It contains 0.16 per cent. of phosphate of lime. If we turn to the analysis of forest trees, we find that the *pollen* of the *pinus abres*, wafted about in clouds, is composed of 3 per cent. phosphate of lime and potash. May not this too be one of nature's beautiful modes of supplying phosphoric acid to plants and to soils? If, as the late experiments of Peschier have proved, sulphate of lime, in powder, is decomposed by growing leaves, the lime liberated, and the sulphuric acid combining with the potash in the plant, why may not phosphate of lime, applied by *pollen*, act in the same way? At any rate, the existence of phosphat of lime in our forest soils is proved, not only by its existence in the pollen, but by its actual detection in the ashes of pine and other trees—100 parts of the ashes of *wood* of *pinus abres*, give 3 per cent. phos. iron; 100 parts of the ashes of the *coal* of *pinus sylvestris* give 1.72 phos. lime, 0.25 phos. iron; 100 parts of ashes of oak coal give 7.1 phos. lime, 3.7 phos. iron.

100	Ashes of	Bass wood	5.4	phos. lime,	3.2	phos. iron,
100	"	Birch	7.3	"	1.25	"
100	"	Oak wood	1.8	"		
100	"	Alder coal	3.45	"	9	"

"These are the calculated results from Berthier's very accurate analysis, and those very curious crystals—detected in some plants—

the 'raphides' of De Candolle, are some of them bibasic phosphats of lime and magnesia. Phosphat of iron, we know, is common in turf; bog ore, and some barren and acid soils owe their acidity to *free* phosphoric acid. If we allow that our untouched forest soil contains phosphat of lime, it may be said, that this, being in small quantity, will be soon exhausted by cultivation, and that the phosphats, which we now find in cultivated fields, rescued from the forest, is due to our manure. I give you the general result of my analysis of *cow dung*, as the best argument in reply. My situation and duties have led me to this analysis. I give you it, in such terms as the farmer may comprehend: water 86.60; hay, 14; biliary water, (bile resin, bile fat and green resin of hay,) 1.275; geine combined with potash, (vegetable extract,) 0.95; albumen, 0.175.

"The hay is little more altered than by chewing. The albumen has disappeared, but its green resin, wax, sulphat and phosphat lime remain, and when we take 100 parts of dung, among its earthy salts we get about 0.23 parts phosphat, 0.12 carbonat, and 0.12 sulphat of lime. Now, a bushel of green dung as evacuated weighs about 87.5 lbs. Of this only 2.40 per cent. are soluble. Of this portion only 0.95 can be considered as soluble geine.

"I have also recently analysed five specimens of soils from Ohio and Illinois, presented to me by H. G. Bowers, Esq., formerly of Northampton, Massachusetts, and now resident in Illinois. They were taken from some of the most productive spots in those States, and, in regard to some of them, it is certain, that no animal or any other manure has ever been applied by man, and at least one of them seems not to have been cultivated, so far as I can judge from its appearance. Yet all these soils contain phosphate of lime. The following are the results of their analysis:

	Soluble geine.	Insoluble geine.	Sulphate of lime.	Phosphate of lime	Carbonate of lime.	Granitic sand.	Water of absorpion.	Remarks.
								*Apparently never cultivated.
Rushville, Illinois	7.4	2.5	3.4	0.6	1.5	84.6	6.3	
Sangamon co, Ill*	4.9	5.6	1.2	0.4	1.3	86.6	6.3	† Cultivated 14 years without manure.
Lazelle co. Ill	7.6	13.8	1.4	0.4	3.3	73.5	9.5	
Peoria co. Ill	3.1	4.8	3.5	1.0	-	87.6	5.7	
Scioto valley, Ohio†	4.5	6.7	2.1	0.9	2.8	83.0	5.3	

"The above soils are evidently of the very first quality: the geine being in large proportion, and the salts quite abundant enough, while there is still a small supply of carbonate of lime to convert more insoluble into soluble geine, whenever occasion demands.

"I apprehend that the importance of the salts of lime in a soil is but

little appreciated by farmers in general. Their crops may fail, although they have manured and tended them well; but it is almost always easy to find a cause that satisfies, in the character of the season; but hard to convince them that the failure may have been owing to the deficiency of a single grain in a hundred, of some substance that can be discovered, when present, only by chemical examination. And yet I doubt not many a crop has failed from the want of that one per cent. of sulphate or phosphate of lime. Facts, indeed, seem to me to warrant the conclusion that, without lime in some form, land will not produce any valuable vegetation.

"Without stopping to notice some things of minor importance, I will state at once the most important conclusions that have forced themselves upon my mind, from all my examinations and analyses of our soils, respecting their deficiencies and the means of remedying them.

First. The grand desideratum in our soils is calcareous matter; that is, carbonate of lime.

The second desideratum is an additional quantity of geine; that is, a larger supply of the food of plants.

"*Hence, thirdly, the great object of the agricultural chemist should be, to discover and bring to light new supplies of both these substances.*

"The discovery of either of them would indeed be of no small value; but it is a principle that ought never to be lost sight of, that an additional quantity of lime in the soil will commonly require an additional quantity of organic matter, and an increase of the latter will be far more serviceable, if attended by an increase of the former.

"The action of lime is threefold, each distinct: 1. It is a *neutralizer;* 2. A *decomposer;* 3. A *converter.* 1. I have already alluded to some acid soils; free phosphoric acid, geic, acetic, and malic acids also occasionally exist in a free state in soils. Here lime acts as a neutralizer. 2. Soils may contain abundant geates, particularly geates of alumina, the least of all demanded by plants. Long formed and sun-baked, they are scarcely acted on by rain or dew, and are almost useless. Here lime, by decomposing these metallic and earthy geates, forms a combination which, in its nascent state, is readily dissolved. If the carbonate of lime acts better than the hydrate, it is because (following a well known law) double decomposition is easier than single. If any acid geine exists in the soil, or any free acids, carbonic acid is then liberated; it acts on the geate of lime, supergeates result, and these are easily soluble.

"3. The great use of lime is as a *converter*, turning solid and insoluble geine, nay, I go farther, solid vegetable fibre into soluble vegetable food. Here is the great puzzle—the point where our philosophy seems to leave us: giving us our choice, to refer this action to one of the numerous cases of mysterious '*catalytic*' change, with which we are becoming every day more and more familiar, or to explain the process by referring the whole to *saponification*. I use this word as conveying to you at once what I mean; but I do not mean to say that the product of lime and vegetable matter is soap; but I cannot make myself more intelligible to a farmer than by saying, this lime makes

compounds of vegetable matter, just as it makes soapy compounds of oil and fat. The action of lime on geine I take to be of the same nature as its action on oils and fat. It is well established that animal and vegetable oils and fats are converted into acids by the action of alkalies, earths, oxides, and even by vegetable fibre itself. The general law is, that whenever a substance, capable of uniting with the acid of fat or oil is placed in contact with fat or oil, it determines the production of acid. Now we have seen that alkali produces a similar change on geine; it developes acid properties. I go farther: if alkali has converted vegetable oil and geine into acids, I see no reason why a similar action may not be produced by all those substances which act thus on oil. Hence lime, earth, and metallic oxides convert geine into acid; as fast as this takes place, so fast it becomes soluble. Then, too, the long action of air on insoluble geine, rendering it soluble, is it not analogous to the action of air on oils? Both evolve in this case vast volumes of carbonic acid; the oil becomes gelatinous and soluble in alkali; does not a similar change occur in geine? It is possible that during the action of lime on geine, a soluble substance may be produced, bearing the same relation to this process that glycerine does to saponification. These views, you will see, need to be followed out experimentally. If found tenable, the most signal benefit will result. We place manures on a new foundation, on which great practical results may be erected.

"Taking the preceding principles as our guide, we may lay down a few general principles for the application of marls.

"1. Enough ought to be applied to neutralise all the free acids in a soil, which may be known by its ceasing to produce acid plants, such as sorrel and pine. Generally, however, the amount required for this purpose is small.

"2. It will be serviceable to add enough to convert the earthy geates of a soil into geate of lime. The richer a soil is, the greater we may conclude is the quantity of geates which it contains.

"3. It will be serviceable to add enough to convert all the insoluble geine and vegetable fibre in a soil into soluble geine. Hence the richer a soil is, and the more manure is added, the more marl will it bear with benefit. Indeed, *there appears to be no danger of adding too much marl, provided a sufficient quantity of manure be also added.* Ignorance of this principle, I apprehend, is the source of most of the failures that have occurred in the use of lime upon soils. Farmers have supposed that its action was like that of common manure, viz: to serve as a direct nourishment to the plant; whereas it only *cooks the food,* if I may be allowed the expression, which exists in the soil, or is added along with the lime. In nearly all cases of over marling which I have read of, a fresh supply of manure has been found to be the remedy; which shows the truth of the above principles. Agriculturists have spread marl alone, or with very little manure, upon land that has been worn out, that is, whose geine has been exhausted; and because such soils have not thereby been recruited, they have inferred that lime was injurious. Without acids, or geine, or geates, or vege-

table fibre, to act upon, much excess of lime appears to operate injuriously, so as to diminish, instead of increasing the crop. They have also expected sudden and surprising increase of fertility; whereas in some cases the chief benefit seemed to consist in causing the land to produce for a greater number of years, by preventing the ultimate decomposition and escape of the organic matter. In general, however, it will add also to the yearly product: but those, who employ marl or lime in any form, ought to moderate their expectations, that they may not be disappointed, and to be satisfied if they can slowly and surely improve their lands, as they most assuredly can do, by this substance, provided they do not expect to accomplish it by the use of lime alone."*

Rise and fall of Lake Erie.

The rise in the waters of Lake Erie was mentioned in the 1st annual report, and a cause suggested, viz: the dam at Black Rock. From more recent observations, although the water way is partially obstructed, and tends to diminish the drainage of the usual quantity of water from the Lake, this is believed to be only one link in a chain of concurrent causes, which have, unitedly, tended to elevate the waters of the Lake several feet above the usual water level.

The effects of this rise are very disastrous upon many parts of the lake coast. Fine farms are completely inundated, and now useless, the coast is in many places washing away more rapidly than heretofore, and it has been necessary to make the wharves higher than before and to fill in earth to raise the streets of some of our towns above the water. A tradition exists, that there is a periodical rise and fall of the water through a certain period of years. If it be true, (and there are reasons for believing it may be to a certain extent,) it is evident that the present rise is higher than has occurred for many years before, for, extensive tracts of forest are now said to be overflowed, and the timber killed in consequence, while the trees by their size, indicate a long period of growth.

The causes that may concur to produce such a variation in the level of the lake, are:

I. An obstruction to the drainage of the usual quantity of water, in consequence of which, if the usual supplies continue, the water must rise.

II. The increased or diminished supply of water, and this supply is dependant

1st. On the wetness or dryness of the season.

2d. On the relative temperatures and amount of evaporation, both from the surface of the lake and the country from which it receives its drainage waters.

3d. The amount of water supplied by the lakes above, as Lake St Clair, Huron, Michigan and Superior. The amount of water contri

*Prof. Hitchcock's Geological Resurvey of Mass. pp, 45, 62.

buted by these, is due to the same general causes as above, with the possible additional one, of an increasing water way from the cutting down of their outlets, and pouring out an additional supply of water.

III. There is another *possible* cause which may be taken into account, viz: the varying level of the solid ground itself. It is scarcely necessary here to remak, that changes of level of the ground have often occurred within the period of history; some rapidly, others by slow degrees, by an actual elevation or depression of the mass of greater or less extents of territory. Examples are mentioned in various works on Geology. The coast of a part of Sweeden is said to be slowly rising at the present time. As water is a fluid, it accommodates itself to a change of level, and does not remain fixed like the solid ground. If the land sinks, the water seems to rise on the shore, although it retains about the same absolute level; and if the land rises, the water recedes from the shore and appears to sink to a lower level.

The variation in level of the land, is not supposed to be a cause of the rise of the lake level, but it is *possible* that it mayhave *some* influence.

It is considered an object of much importance to determine what are the causes of the effect, and it was intended, if the Legislature had made an appropriation corresponding to the estimate, and with the provisions in the bill which was reported during the last session, to have set in train a series of observations in several locations on the lake coast, and in different parts of the State, so that by the period for the close of the survey, a determination of the causes of the rise and fall of the lake may have been attained. All the aids that the various branches of Meterology could have secured would have been put in requisition. The series of observations on the coast would also have decided the question as to the small *tides* which are said to be very sensible in some places.

The plan of operations was matured, and may still be carried into effect, if the Legislature should see fit to authorize it.

Brick Manufacture.

As bricks are extensively manufactured near some of our large towns, and wood has already become a large item in the expense of manufacture, I may be permitted to suggest an improvement, which will not only diminish the expense of production, but improve the quality of the material.

The improvement consists in mixing 4 to 6 bushels of the ashes and half burnt coal, (which falls through the grate in burning stone coal) with such a quantity of the clay as will make 1000 bricks; or say 500 bushels of this substance in a kiln of 100,000 bricks. This coal ashes and cinder should be ground pretty fine before it is mixed with the clay. It should be mixed with the clay at the same time that the sand is ground or trod up with it before moulding. This method has long been in use in Europe, and particularly in England, where their bricks are required by law to be made in this manner. It gives them greater strength and durability, while, at the same time, it economises the con-

sumption of the wood or coal that is used for burning in the arches of the kiln. The cinder of the coal ashes, as it is commonly called, is mostly coke, or the carbon of the coal, freed from its bitumen. When mixed with the clay of the brick, and the brick becomes ignited in the burning, this carbonaceous matter burns away, and the heat coming from its combustion is applied just where it is wanted, viz: in every part of every individual brick. This method is extensively applied in the burning of bricks on the Hudson river, where about 100,000,000 of bricks are made annually, except, that the dust of anthracite coal is there employed instead of coal cinders. Ground coke would answer the same purpose, and about 2 to 2½ bushels to 1000 bricks would probably be sufficient. The quantity of dust anthracite employed in the Hudson river brick yards, is about 3 pecks to 1000 bricks, or 75 bushels to 100,000 bricks. Their kilns generally contain 300,000 to 400,000 bricks, but some are burnt containing 1,000,000. The time formerly required to burn their brick kilns with wood alone, was about 13 to 14 days. It took about 40 cords of oak wood to 100,000 bricks. With this improved method, they burn their kilns in 3 to 4 days, with a consumption of only 16 cords of wood to 100,000 bricks. Wood is there worth 5 dollars per cord, and dust anthracite costs $0,75 to $1,25 per ton.

The former cost of burning was as follows:

For 100,000—40 cords wood at $5 per cord	$200
14 days attendance, say	20
	$220

By the improved method, the cost is,

For 100,000—16 cords wood at $5 per cord	$80
75 bushels dust anthracite, at $1 per ton	3
4 days attendance	6
	$89

The expense of burning is thus reduced to less than one half its former amount, while the time of effecting the burning is reduced to less than one third.

It is necessary to caution brick-makers not to mix much more of coal ashes or of coke in their clay, than the quantities specified, else they may melt their bricks into a solid mass, and render them worthless.

There are many places which have come under our examination during the progress of the survey, where the expenditure of a small sum of money, say from $10 to 100 in each locality, would settle questions of greater or less importance, such as determining the presence of expected valuable minerals, the junctions of rocks, the superposition, amount of dip, and various other points, where natural or artificial facilities, such as ravines, mines, excavations for wells, rail roads, &c. did not exist. These questions often involve important economical results to the community, and it is deemed of sufficient

moment to induce me to lay the matter before the Legislature, that they may, if they should deem it expedient, place a small additional fund at the disposal of the geologist for application to such purposes.

There are several other sources of contingent expenses that ought to be provided for: such as for rent of laboratory, fuel, apparatus, and materials, instruments for the different departments of the survey, boxes and transport for the specimens which are collected in obedience to the requisitions of the law for the survey, procuring temporary local assistance in the topographical and other departments, and various other items which it is not necessary to mention.

At the last session, the Governor was authorized to expend $1000 for geological books to go into the State library for aiding in the geological survey, and which ought to be in every public library, but as this amonnt was expected to be disbursed from the appropriation for the geological survey, and as that appropriation was not made, the books have not been procured or ordered, and cannot be until the funds for their purchase shall have been appropriated.

The estimate of last year was based upon the then compensation of the members of the geological board, the contingent expenses above enumerated, and the employment of local assistants in the different counties where there were persons qualified for the various branches of duty, and who were familiar with the topography of the country around them.

That estimate, viz: $16,000, if adopted by the Legislature, will be sufficient for the current annual expenses including all the contingencies enumerated.

Prof. Kirtland, who has charge of the department of zoology and botany, has been engaged during the past year, in preparing his catalogues of the different branches of animated nature, and in investigating various subjects which have a practical bearing, and which are connected with his appropriate sphere of duty. Prof. Kirtland suspended his pay from the State in the early part of the summer, so as to enable the geologists to continue their field labors for the benefit of the State, for a longer time than they could otherwise have done, as the funds on hand were insufficient to continue them all at ther labors, through the season.

Prof. Locke was instructed to make the surveys of Butler and Adams counties.

He has executed a geological section from the west line of the State eastward to—

The details of his investigations will be found in his report.

Professor Locke's report is not yet received, but it is expected in a few days. He was directed to examine into the economical geology of Butler and Adams counties. I have received no semi-monthly or monthly reports from this gentleman as to the progress of the work committed to his charge; and of course, I have no official means of knowing whether any discoveries have been made of any economical value.

Prof. Locke has made some interesting and important observations on the dip and variation of the magnetic needle, and on the magnetic intensity in different parts of the State. These observations are in

addition to his appropriate sphere of duties on the geological survey, and they are not only interesting to science, but they have an important practical bearing.

The determination of the variation will aid in the running out of old lines of surveys in the Virginia military district, the lines of the seperate tracts of which were run, as, is well known, without any regard to system or regularity. The determination of the varying intensity of terrestrial magnetism affecting the magnetic needle, when generally determined throughout the State, will afford a means of tracing out local or extensive deposits of iron ore, where there are no external indications to point them out.

Proff. Briggs has been employed the past season in prosecuting the unfinished surveys of last year in the country between the Scioto and Hockhocking. Of this district, he has made the surveys of Hocking and Athens counties. He was also directed to make, and has executed, the surveys of Crawford, Wood and Tuscarawas counties. The developments of mineral wealth are highly satisfactory, and exceed the expectations formed.

The details will be found in Proff. Briggs' report, which is annexed.

Mr. Foster has been employed about one half the past season in making the geological surveys of Muskingum and Licking counties.

The result has been to develope many beds of coal, ore, limestone, &c. where they were not before known; to lead many owners of property to appreciate their mineral wealth; and to trace out the mineral deposites on fixed geological principles. The coal beds on and near the Muskingum river must soon become valuable. The improvements in the navigation, by means of locks and dams, will permit barges and boats of a large class to take in their freight of coal or other products of our soil, at our towns and mines, and proceed directly to their destination, without transhipment. This will enable the people of the Muskingum valley to ship their produce at an expense scarcely exceeding that of the immediately valley of the Ohio.

Col. Whittlesey, the topographer of the geological survey, in consequence of the funds on hand for disbursement being inadequate to keep the geologists in the field, and supply him the means of procuring as much assistance as his appropriate sphere of duties demanded, has been employed a portion of the past season in making the geological investigations in Portage and Trumbull counties, and tracing out the boundaries of the coal formation in that vicinity. There is a much greater extent of coal beds in that region than was known before, and some of them will undoubtedly be worked; but in many places they are too thin or of too poor a quality, to be worked with profit at the present time.

During a portion of the season, Col. Whittlesey has been employed in running a series of levels across the outcropping edges of the strata, along the western boundary of the coal and iron region of the State, with a view to determine the amount of dip, and ascertain what breadth of country is underlaid by the particular beds of coal, iron ore, limestone, &c. and so near the surface as to be accessible without incurring much expense in their exploration.

He has also employed a portion of his time in surveying the remains of ancient works, which are so common in the valleys of our principal streams. It is believed that data for plotting and describing more than one hundred of these works have already been obtained by this gentleman.

Col. Whittlesey has collected an extensive series of observations made by the county surveyors of Ohio, and by scientific men in various parts of the world, on the variations of the magnetic needle, &c. A valuable mass of matter is embraced in this part of his report, and it will be appreciated by the community.

A large collection of specimens to illustrate the useful, as well as curious mineral products of the counties examined this year, has been made, but no means are at our disposal for procuring cases in which to display them, or even pay for their transportation to this city.

Eleven counties have now been examined, not, however, with that minuteness of detail that is necessary, either for a full development of their resources, to confer the greatest benefit on the owners of the soil, or to satisfy scientific men on many points of economical and scientific interest; but, such as would satisfy public opinion of the utility and practical value of the survey, by a partial development of the mineral wealth, and lead them to appreciate the value of more minute researches.

Should the Legislature see fit to discontinue the survey, I am prepared to compile the materials already accumulated to illustrate the mineralogy and geology of the State, with maps, diagrams, &c. in accordance with the act authorizing it; and should they see fit to continue it, the geological board is organized, though small; the laboratory is prepared, and every department of the survey ready for efficient action.

The soils and mineral waters have not yet been analyzed, and the same may be said of the minerals, with the exception of the coals and iron ores of a few localities. The laboratory is now completely prepared for active analytical operations.

Eleven counties have been surveyed at an expense of $12,000, and nearly $2000 of this amount has been disbursed for apparatus, books, and materials for the laboratory, instruments for the Topographical department, cases for the display of the minerals collected for illustrating the mineralogy and geology of the State, and other small items.

The average expense of the survey of each county, has thus far been about $1000, while the benefit resulting to a single one of these arising from the increased valuation of real estate, incident to the developments of mineral wealth, is estimated at least at $100,000, and by some at $500,000. So it must be with other counties, as their resources are made known, and are appreciated.

Ohio has never yet retraced her steps in any work of public utility that she has undertaken, and the idea can scarcely be entertained, that she will withhold the appropriation of a few thousands, by the expenditure of which millions will be returned to her citizens.

W. W. MATHER, *Principal Geologist of Ohio.*

APPENDIX

TO MR. MATHER'S REPORT.

In order that our citizens and scientific men may be enabled to judge whether confidence may be placed in the results of the analyses that have been given in the preceding report, I will state the general principles upon which the investigations have been conducted, and as many of the details as may be necessary to a thorough understanding of the manipulations employed.

The analyses of the coal and iron ores have not been carried out with all that rigor that purely scientific investigations would require; for the end in view was, not so much ultimate, as proximate analysis, for practical purposes merely. I will take examples of the analysis of a coal and its coke, and of an assay and analysis of an iron ore, as sufficient for illustration. They are from the laboratory journal of February and March, 1838.

In the examination of coal, the following points were determined, not on the same identical fragment, but on separate fragments of a piece broken from the mass of the coal which was supposed to be of a medium quality of the bed or mine examined.

Specific gravity.
Hygrometric water.
Bitumen and volatilizable matter.
Quantity of coke.
Do carbon in the coke.
Do sulphur.
Do iron.
Do earthy materials.

Examination of coal from Dr. D. Upson's mine, Talmadge, Portage co , O.

Description. The coal breaks into irregular rectangular fragments, is black and soft, with a resinous shining lustre on the freshly fractured surfaces. The specimen examined was not selected by myself at the mine, but was presented by the proprietor, as of an average quality of that part of the coal bed that is used as blacksmiths' coal. Scales of yellow sulphuret of iron were observed in some of the thin seams and fissures in the coal.

[A.] *Specific gravity.*

Distilled water at the temperature of 63 degrees F. Ballance weight, = 371 grains.

Weight of specimen of the coal in air, (in grains) =371.0—223.0=148.0
Do do do in water - - =371.0—340.0= 31.0

Loss of weight in water - - - - - - - - - - - - - - - - 117.0
Specific gravity at 63 degrees F. - - - - - - - 148.0÷117.0=1.264

[B.] *Hygrometric water.*

148 grains of the coal after exposure one hour to a temperature of about 200 degrees F. in the warm air chamber, weighed 140.5 grains, having lost 7.5 grains of hygrometric water=to 5.067 per cent; for 148. : 7.5 : : 100 : x=5.067.*

[C.] *Coking.*

(*a.*) 1000 grains of the coal when coked, by heating it to whiteness in a double, closely covered and luted crucible, gave 553.55 grains of coke,= 55.35 per cent.

(*b.*) 500 grains in another experiment gave 277.6 grains of coke=55. 52 per cent.

(*c.*) The coke is good so far as the eye can judge from coke prepared in the small way. It is hard, brilliant, and tolerably compact. The mean of the above experiments which are as good comparative results as one would expect from fragments taken from different parts of a piece of the coal is=55.355+55.522÷2=55.425.

[D.] *Earthly and metallic materials in this coal.*

(*a.*) 69 grains of the coal of Upson's mine were ignited in a small platinum crucible in the lamp furnace.† The crucible weighs 281.55 grains, and with its contents 350.55.

After perfect incineration of the coal, the crucible and its contents weighed 282.95 grains; whence the ashes or earthy matter of 69 grains of the coal was 282.95—281.55=1.40 which is equal to 2.1 per cent; for 69 : 1.4 : : 100 : x=2.1.

(*b.*) In another experiment, 47 grains by incineration left 0.85 grains of ashes or earthy matter=1.808 per cent.

(c.) The mean of these two experiments of incineration is 1.954 per cent of earthy and metalic matter.

[E.] *Sulphur and iron.*

In order to ascertain if sulphur and iron entered into the compo-

*The hygrometric water was generally determined by heating as above in a hot air chamber, in which the heat could be regulated at about the boiling temperature of water by steam.

† An alcahol lamp furnace, with a large double circular wick, and with a double chimney to prevent loss of coloric by radiation, and with several peculiarities of construction, is made use of for the incineration of carbonacious substances, in which the carbon is entirely, burnt away, leaving the incombustible residue. It is very convenient for many purposes in the laboratory, and answers for all the ordinary heating processes on small bodies, except for assays of ores.

sition of the coal, a small quantity of the pulverized coke was treated with dilute muriatic acid. There was a slight evolution of sulphuretted hydrogen indicative of the presence of a sulphuret in the coke. The muriatic solution when filtered, to separate it from the pulverized coke, and tested with ferrocyanate of potassa, gave a blue precipitate, indicative of iron. These two experiments show the presence of protosulphuret of iron in the coke, which was expected, as pyrites had been observed in the coal.

(a.) To ascertain the proportions of the sulphur and iron in the coke, 91.2 grains of the finely pulverized coke were treated with muriatic acid. A few drops of nitric acid were added to peroxidize the iron. The solution was dosed with an excess of ammonia, to precipitate the iron as a hydrated peroxide. After the perfect separation of the precipitate, the clear supernatent liquid was decanted by means of a capillary syphon, from which the liquid merely drops, so that it can be drawn down very near the precipitate without disturbing it. The syphon was withdrawn, and distilled water added to the precipitate, and after settling clear, this was also drawn off.* When the precipitate was thus washed pretty clean of the muriatic solution, it was thrown upon a small double filter of equal weights, and every particle washed with distilled water from the precipitating glass, from which the decantation had taken place. The precipitate and filters were washed with fresh distilled water, as long as there was the least perceptible taste. These washings were all added to the decanted solution. The precipitate of hydrated peroxide of iron on the double filter was dried, and when ignited weighed 1.14 grains†=1.254

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*My decanting capillary syphons are inserted in a cork which is put in the one of the openings of a double necked bottle when in use, and by putting a glass tube which passes through a perforated cork into the other neck and sucking through it, with the short leg of the syphon in the liquid to bed ecanted. When once set in operation in this way, it continues until the liquid is drawn off to the bottom of the syphon. It is drawn off drop by drop, without any chance of loss, if the operator has any skill in manipulation. This method is, I conceive, far preferable to any other, in accurate chemical analysis, and I have used it with success for some years.

†In many of the analyses the minute details of manipulation are not stated at length, as it would make much more writing in the journal than is necessary, but the following is the method uniformly pursued to obtain the result as stated above. The precipitate on its double filter of equal weights and contained in the funnel in which the filtration and washing had been effected, was placed to dry in one of the funnel holes in the steam bath, and covered with a paper cap or jacket. All access of dust is thus avoided, while it is kept at a temperature of 206 deg. to 212 deg. F. and perfectly from the access of any vapor, except that coming from its own evaporation. (The steam bath condenses most of its steam, and the remainder is conducted off. The funnel holes are air tight with the steam around them.) When the precipitate has become as uniformly dry through its mass, as the temperature above can effect, the double filters are removed, the loaded filter placed in one scale of the balance, and the empty one in the other. The difference of weight, (as they were made of equal weight before use, and have been similarly treated since,) will be equal to the weight of the dry precipitate. Such a portion of this

grains of protosulphuret of iron=1.375 per cent in the coke=1.03 per cent of bisulphuret of iron in the coal=0.875 per cent of iron in the coke =0.484 per cent of iron in the coal.

(*b*.) The pulverized coke which had been treated with muriatic and a few drops of nitric acid to remove the iron, sulphur and soluble matters, was carefully washed by means of the capillary syphon, then thrown upon the double filter of equal weights and washed with the dropping bottle which dripped water all around on the edges of the filter as well as on the carbon, as long as any thing soluble remained in either.* The filters and the contents were dried in the steam bath for two days, at a temperature, varying from 100 degress to 212 degrees F. The filters were separated and placed in the opposite scales of the balance. The difference of weight of the loaded and empty filters was 90.6 grains, which shews the weight of the residue of the coke dried at this temperature. As the coke used in the analysis was freshly ignited before use, it is necessary to ignite this to learn the loss of weight.

87 grains of the carbonaceous residue were ignited in the way before mentioned. The loss was 0.55 grains, whence the 90.6 grains on the filter would have lost, had it all been ignited, 0.572 grains. The entire loss of the coke, therefore, by digestion with nitric and muriatic acids is =91.2—90.6+0.572 grains,=1.172 grains,=1.28 per cent. The weight of protosulphuret of iron in the coke, was estimated, from the quantity of peroxide of iron obtained,† at 1.375 per cent. The entire loss of the

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precipitate is then detached from the filter, as can be, without inconvenience, and placed in a small platinum crucible which has been just before carefully weighed, and then again weighed. The difference between the first and second weights is the weight of the substance removed from the filter. The crucible and its contents are now ignited, and as they cool, the crucible is kept covered to prevent the absorption of hygrometric moisture by the ignited body. As soon as the crucible is cool, so that it will not produce ascending currents of air to diminish the weight, it is placed again in the balance and weighed. The difference between the second and this third weight is the loss of weight sustained by ignition. Then knowing the weight ignited, the loss by ignition, and the weight of the precipitate on the double filter (indicated by the difference of weight between the loaded and empty filters of equal weights,) we have data to determine the weight of the whole precipitate as if the whole had been ignited. I prefer this method to that of burning the filters, and to all others that I know to be practiced, for reasons that every chemist will appreciate. There is no transferrence of materials between weighings, by which a slight loss must always be sustained, and no reduction of iron or change of composition of the materials, such as would be due to the ignition and combustion of carbonaceous materials in contact with the precipitate at a red heat. It is necessary to weigh the crucible carefully before and after use every time, for, with a delicate balance, a slight diminution of one fiftieth to one thousandth grain is experienced every time that it is employed, and in accurate investigations it becomes necessary to take this into account.

*The solution and washings here referred to have been dissolved and the iron precipitated from it and ignited aud weighed in (E) (a.)

†Vide, (E) (*a*.)

coke by digestion has been shown to be 1.28 per cent. It follows that the amount of sulphur in the coke is less than is due to a perfect combination as protosulphuret of iron. This is easily accounted for in consequence of the tendency of carbon to combine with sulphur at a high temperature, to form sulphuret of carbon, which passes off as vapor, while a portion of the iron is reduced to the metallic state. This does not, however, affect the calculation of the quantity of bisulphuret of iron in the coal, where it is visible as bisulphuret, and where all the iron in the coal is judged to be combined with sulphur.

(c.) The sulphur in the analysis of which this is a part, was not separated and estimated in the usual way, but was estimated by calculation, taking the sulphuret of iron in the coke, at a mean of the quantity calculated from the peroxide of iron obtained, and the loss of the coke by digestion with muriatic acid or protosulphuret of iron$=1.375+1.28 \div 2=0.737=$ 1.005 bisulphuret of iron; for, $28+16 : 28+(16\times2) :: 0.737 : x = 1.005$. This method, however, is open to strong objections. If the sulphur be estimated from the equivalent of peroxide of iron, it will give 0.912 grains; for, $28+12 : 16\times2 :: 1.14 : x=0.912=0.459$ per cent of sulphur in the coal. The method usually pursued has been to precipitate the sulphur from the solution from which the iron had been previously precipitated, and the decantation, filtering and washing, completed as in (E) (a), by adding a solution of muriate of baryta. The sulphur in the sulphuret of iron of the coke is converted by the combined action of the nitric and muriatic acids into sulphuric acid, which remains in the solution until precipitated by muriate of baryta as sulphate of baryta. If, however, the solution of the iron be effected without the acids being strong and warm, a part of the sulphur is separated, and floats in the liquid, and remains, when filtered with the coke, in which case it cannot be estimated correctly without much trouble. On the other hand, if heat and strong acids be employed, they react on the carbon of the coke, and cause a loss of carbon which passes off in the form of chloride of carbon and carbonic acid. Separate portions of coke are, therefore, used for these determinations. The methods of Rose for determining the quantity of sulphur are the best, and least exceptionable, but they have not been used in these analyses, since it was not deemed necessary for the objects in view to go into rigidly minute investigations.

(F) The quantity of carbon in the coke is calculated by differences between the weight of coke experimented on, and the obtained quantities of earthy matter and the protosulphuret of iron. This would give 96.355 per cent; for 69 grains of coal have been shewn to yield a mean of 1.954 per cent of earthy and metallic matter by incineration, vide (D) (c) =to 3.52 per cent for coke. 2d, 91.2 grains of coke have been shewn to yield 1.14 grains of peroxide of iron=1.25 per cent. 3d, the difference between these, viz: $3.52-1.25=2.27$ is=to the earthy materials in the coke. 4th, the 1.25 per cent of peroxide of iron in the coke is equivalent to 1.375 per cent of protosulphuret of iron; and 5th, as the iron in the earthy matter derived from the incineration of the coal would be in the state of a peroxide, the earthy matters=2.27 added to the protosulphuret of iron=1.375, and subtracted from the coke, 100, would give as far as this method is susceptible of accuracy, the weight of the residual matter, or carbon of the coke =96.355 per cent.

This method of calculating by differences has however been rarely employed, in consequence of the many strong objections and the tendency to error.

The method of Berthier has generally been used in my analyses of carbonaceous compounds, and from the ease of its application, and the approximation to accuracy in its results, it ought to be in common use.

As this method may not be known to all our chemists who are analyzing coals, I may be permitted to make the following extract from my laboratory journal, which will show the method of Berthier, with some slight modifications which experience has suggested.

"37.5 grains of the pulverized coke of Howe's mine were mixed with 1500 grains of pure litharge, and placed in a closely covered crucible which was enclosed in other crucibles," so as to prevent all access of the carbonic oxide of the fire from exercising its reducing tendency on the oxide of lead. "The crucibles were first subjected to a strong red heat in the furnace for an hour, to reduce the oxide of lead, by the contact of the carbon, which was intimately mixed, but not high enough to melt the oxide. The heat was then increased to whiteness for an hour to render the excess of oxide perfectly fluid and permit all the globules of lead to coalesce into a single globule or culot. The crucible was then removed from the furnace and allowed to cool. It was then broken, and the culot of lead detached. The cinder, or silicate of lead derived from the combination of the excess of the oxide with the silex of the sides of the crucible, was a perfectly transparant green glass, and contained no globules of lead."

"The culot of lead weighed 638.8 grains." "As there were some particles of the green glassy cinder adhering to the culot of lead, which could not be detached without a chance of a small loss, the entire culot of lead was placed in a brasqued crucible. The culot of lead was covered about one inch with kneaded charcoal dust and water, to prevent all access of air, and heated to bright redness in a covered brasqued crucible. The brasque was highly polished to prevent the slightest adhesion, or separation of particles of lead from the culot. The culot when removed from the crucible after it had been withdrawn from the fire and cooled, was found to be smooth and free from all impurities. It weighed 615.4 grains.

"It has been shown, vide Laboratory journal, p. 9, that this coke of Howe's mine contained 0.7 per cent of protosulphuret of iron, and as this would deoxidize the litharge, (the sulphur passing off as sulphurous acid, and the oxide of iron combining with the cinder) we must make a proper allowance for this. The quantity of coke used in this part of the analysis, viz: 37.5 grains, would, at this rate, contain 0.26 grains of protosulphuret of iron; and as 100 of protosulphuret of iron produce by reduction 720 of lead from litharge,*† 0.26 grains of protosulphuret of iron would reduce 1.87 grains of lead."

The lead from which the carbon is to be estimated is $615.4-1.87=613.53$ grains.

The quantity of carbon equivalent to 613.53 grains is 35.395 grains; for, 104 the atomic weight of lead : 6 the atomic weight of carbon : : 613.53 lead : x the carbon in the coke. $x=35.395$ grains $=94.38$ per cent.‡

The atomic numbers used in the preceding calculations are not, perhaps, strictly accurate; but they are such as have been in common use, and an-

*There must be an error in this statement of Berthier, probably typographical, as it differs both from atomic proportions, and from the results assays. The calculated atomic proportions approach the truth.

†Berthier Traite des Essais par la Voie Seche 1, p. 309.

‡Laboratory Journal, O. G. S. by W. W. Mather, pp. 10, 25.

swer the purpose intended in this place, viz: the illustration of the principles employed in analytical operations. I have no books by me in which the most recent researches on atomic proportions are discussed, but the above calculations can be easily altered, by substituting the proper atomic numbers should any occasion require.

The results of the analysis of the coke of Howe's mine, of which the above quotation shows a part of the details of operating, are given below.

Composition of the coke of Howe's mine, Jackson county, Ohio.

Carbon, - - - - - - - - - -	94.38
Protosulphuret of iron, - - - - - - - - -	0.70
Earthy matter from incineration, - - - - - -	3.32
Hygrometric water, - - - - - - -	1.33
Loss, - - - - - - - -	0.27
Total, - - - - - - - -	100.00

Recapitulation of the items determined in the composition of coal from D. Upson's mine, Talmadge, Portage county, Ohio.

Coke containing the earthy and metallic matter of the coal,	55.425
Bitumen=39.505 volatile matter—0.274 sulphur= - -	39.231
Sulphur volatilized with the bitumen, - - - -	0.274
Hygrometric water, - - - - - - - -	5.067
Loss, - - - - - - - - -	0.003
	100.000

The coke in the above recapiutlation is composed as follows:

Composition of coke of Hon. D. Upson's mine.

Carbon, - - - - - - - -	96.355 (J)
Protosulphuret of iron, - - - - - -	1.375 (E) (a)
Earthy matter, - - - - - -	2.270 (F)
	100.000

Some of the determinations in this analysis having been made by differences, they necessarily show no loss, although a small loss was undoubtedly sustained.

Assay of iron ore from below the Buhr stone, near Radcliff's, Jackson county, Ohio.

(A) *Description of the ore.*

Compact, porous, in some places; color like common brown oxide of iron; powder yellow.

Specific gravity 3.09, as ascertained by J. W. Foster, Esq.

(B) (1) 50 grains of the powdered ore after ignition were found to have lost 6.8 grains=13.6 per cent.

(2) 50 grains treated as above, lost 6.45 grains=12.9 per cent.

The above losses are due to the vaporization of the hygrometric water and the water of combination.*

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*The details of manipulation in this operation were the same as have been already described in the analysis of coal.

Preliminary examinations had been made by heating the pulverized ore

The mean of the results (1) and (2) gives 13.25 per cent of water.

(C). 100 grains of the fluor spar which is to be used as a flux for the ore in the assay, was ignited by Mr. Foster. The loss of weight was 0.51 grains=1.02 per cent of hygrometric water.

Assay.

(D) (*a*) 250 grains of the pulverized ore and } were mixed
250 " " " " fluor spar }

intimately and placed in the polished cavity of a brasqued crucible.* The mixture of ore and flux was crowded compactly into the cavity in the brasque of the crucible and then covered with lampblack which was crowded down solidly upon the top of the ore and flux, to fill the cavity of the brasque. The brasqued crucible was covered by inverting another over it. The one containing the assay was placed in another, and the space at the junction of the three was luted with a vitrifiable mixture. All access of air in the furnace to burn away the carbon of the brasque is cut off, and to make it still more perfect, the tops of the crucibles in my assays have generally been ground down to a flat surface so as to fit more closely.

(*b*.) The crucible thus prepared was placed in the wind furnace, which is heated with coke, and kept at a high white heat for 4 or 5 hours.

(*c*.) The crucibles were then removed, and after cooling, were detached, and the culot of cinder and iron taken out from the cavity in the brasque.

The fusion had been complete, and all the iron except a few small globules which were observed in the cinder, was collected into one large globule.

The cinder was white, showing that the iron had all been reduced to the metallic state, and in texture it was compact, with some tendency to crystalization in a few places.

(*d*.) The weight of the entire culot was, according to Mr. Briggs, 403.6 gr
" " " iron detached " " " 151.1

Whence the weight of the cinder was 403.6—151.1=252.5

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in small tube retorts, holding a few grains of the ore, and connected with tube receivers containing coursely powdered chloride of calcium, which was kept in its place by wads of amianthus. The end of the tube receiver, remote from the tube retort, was drawn down to a capillary tube, and placed under the open end of a graduated tube filled with mercury, so as to collect any gaseous matter evolved by igniting the pulverized ore in the retort. Water was evolved by the heat and condensed by the chloride of calcium, while no more gas was received in the mercurial receiver than was due to the expansion of the air in the tube retort, by heating it.

*The method I have used in brasquing crucibles for assays of ores, is to crowd lamp black solidly into hessian crucibles with a smooth stick, then bore a hole into the solid lamp black with a small spatula, then shape the cavity with the spatula, and polish the sides and bottom of the cavity with a tube that has a smooth hemispherical closed end. As this solid lamp black is found to crack occasionally at a high temperature, and thus destroy the accuracy of the assay, I have for some years been in the habit of mixing some finely powdered charcoal with it, kneaking them with water, and crowding the damp mass into the crucible as above.

The 250 grains of fluor spar used as a flux in the assay, have been shown to contain 0.51 per cent of hygrometric water=1.27 grains in 250 of fluor; hence, the actual quantity of dry fluor spar used in the assay was 248.73 grains=250—1.27.

(*e*.) The cinder obtained in the assay and separated from the iron, has been shown above to weigh 252.5 grains, which exceeds the weight of the flux employed 3.77 grains, for, 252.5 grains of cinder—248.73 grains of flux=3.77 grains. This increase of weight in the cinder, is due to the combination of the earthy materials in the ore, with the fluor spar of the flux. As 250 grains of ore were used in the assay, and 3.77 grains of earthy matter combined with the flux, we have, by calculation, 1.508 per cent of fixed earthy matter in the ore.

(*f*.) The entire weight of the culot, both iron and cinder, has been shown, vide (d.), to weigh 403.6 grains, and the weight of the ore and flux employed in the assay, was 250 grains of ore, +248.73 grains of dry fluor,=498.73 grains. The difference of these quantities, viz: 498.73—403.6 grains=95.13, shows the loss of weight sustained by the ore by heat, and by reduction to the metallic state. This loss of weight is due to the escape of hygrometric water, the water of combination, the escape of oxygen in the form of carbonic oxide, by the reduction of the oxide, and of any other volatile materials that may have been combined or mixed with the ore.

(*g*.) The hygrometric water and water of combination in the ore, have been shewn (vide B.) to be=13.25 per cent. The remainder of the loss of weight sustained by the ore in the assay=62.005 grains (=95.13—33.125*) is due to the escape of oxygen and other volatile matters of the ore. The iron obtained from 250 grains of ore was 151.1 grains. This iron is in the state of cast iron, and contains about three per cent of carbon=146.56 grains of pure iron, for, 100 : 3 : : 151.1 : x=4.533 and 151.1—4.533=146.567 grains, and this quantity of iron is equivalent to 62.814 grains of oxygen in the peroxide; for, 28 iron : 12 oxygen in the peroxide : : 146.567 iron : x=62.814 grains.

Recapitulation of the results of the assay.

Iron 151.1=pure iron	146.567	vide g =	58.626 per cent.
Oxygen combined	62.005	" g =	24.802 " "
Water hygrometric and combined	33.125	" g =	13.250 " "
Earthy matter	3.770	" e =	1.508 " "
Loss	4.535		1.814 " "
Total	250.000		100.000

The above loss is larger than is usual in well conducted assays, and it is probably due to having assumed a larger quantity of carbon as combined with the iron, than really existed in it. The ordinary mode of calculation, is to consider the iron in the culot as pure iron, and put it down as such in the results of the assay, without making any allowance for combined carbon. Were we to state the results obtained in that way, there would

*This number, 33.125 grains, is the quantity of hygrometric and combined water in 250 grains of the ore, for, 100 grains of ore : 13.25 grains of water : : 250 grains of ore : x and x =33.125.

be no apparant loss: but the above is the proper way to state the results. As a means of comparison, the results are stated below upon the arbitrary consideration that the iron in the culot was pure.

Recapitulation.

Iron in the culot - - - - - -	151.100	60.440
Oxygen combined - - - -	62.005	24.802
Water, hygrometric and combined	33.125	13.250
Earthy matter - - - - - - -	3.770	1.508
	250.000	100.000

Assay of iron ore from the "Big ore bed," on Mr. James Rodgers' tract, near Jackson furnace, Hamilton township, Jackson county, Ohio.

Description.

This ore bed is about 6 feet thick. It is the "kidney ore," of a reddish brown color, in nodules with concentric laminae. The nodules are frequently hollow, or with clay and earth in the centre. The fracture is fine grained, uneven, earthy, and dull. Hardness 2. In composition it is limonite, or a hydrated peroxide of iron. In geological position this ore bed is believed to be about 70 or 80 feet above the lower workable bed of coal which in some parts of Jackson county is called the Crookham seam.*

Assay.

200 grains of the pulverized ore, 200 " " " fluor spar, } =400 grains, were placed in a brasqued crucible in the air furnace.

Result.

Entire culot, - - - -	329.8 grains.
Iron in a button with some globules, - - -	97.5
Cinder=the difference= - - - -	232.3

The flux gained 32.3; for 232.3—200=32.2. Loss by fusion, consisting of oxygen, water, and perhaps a little zinc, as this is occasionally found in the ore=400—329.8=70.2 grains=35.1 per cent.

Hygrometric water, 0.62=0.31 per cent.

Loss of water by ignition 26.2=13.1 per cent.

Water of combination=26.2—0.62=25.58=12.79 per cent.

* The Crookham coal seam lies in many parts of Jackson county about 70 or 80 feet above the conglomerate rock which forms a floor to the proper coal measures. A thin seam of coal called the "Henry seam" which is in some places common bituminous coal, and in others cannel coal, and in others, bituminous shale, lies within a few feet above the conglomerate; and two seams of iron ore, called "block ore," intervene between the conglomerate and the Crookham seam.

Recapitulation of results of the assay of the iron ore of Big Bed, Jackson county, Ohio.

Oxide of iron composed of	Iron, - - - - -	48.75
	Oxygen, - - - -	20.89
	Water of combination	12.79
Hygrometric water, - - - - - - - -		0.31
Earthy matters fixed, - - - - - -		16.15
Loss, a part of which is probably sulphuret of zinc, - -		1.11
		100.00

It is believed to be unnecessary to extend this paper to a greater length by going into the details of analysis in the wet way.

The results of an analysis of oolitic iron ore from near Zanesville, Muskingum county, by J. W. Foster, Esq., are subjoined. It was not entirely completed. Many analyses which were commenced, on substances of practical importance to the community, were left unfinished, at the commencement of the period for the geological board to begin their field labors. The substantial means to prosecute them, are now wanting. It can scarcely be doubted that the analysis of our soils, ores, coals, limestones, marls, clays, &c., will be very valuable to the community, and cause many improvements in their applications and in methods of manufacture.

Results of Mr. Foster's analysis.

Peroxide of iron, - - - - - -	25.212
Earthy matter, - - - - - -	12.444
Water of combination - - - - -	10.550
" hygrometric, - - - - - -	0.750
Undetermined matter, - - - - -	0.725
Earth soluble in muriatic acid, - - -	0.200
Lime, - - - - - - - - -	0.056
Loss, - - - - - - - -	0.063
	50.000

W. W. MATHER,
Principal Geologist of Ohio.

MR. WHITTLESEY'S REPORT.

To W. W. MATHER, *Principal Geologist of Ohio:*

During the early part of this year, and until the advanced state of the crops and the foliage offered obstructions to such operations, I prosecuted the measurements for ascertaining the dip of strata, according to your instructions.*

The results are herewith presented.

BLOOM TOWNSHIP, SCIOTO COUNTY.

Neighborhood of Scioto Furnace, east part of county; dip S. 77° 40′ E. 101 feet per mile; mean of three planes. Two other planes at the same place, gave North 62° 45′ E. 37½ feet per mile.

This was in the coal and iron strata, near their Western outcrop, where the lines were necessarily short. They were from ¼ to ¾ of a mile in length, and the level disclosed great inequallities in the dip.

LICK TOWNSHIP, JACKSON COUNTY.

Neighborhood of Strong's tavern; coal strata; dip N. 64° 18′ E. mean of five planes—direction of dip uniform; amount, variable and decreasing Eastward from 145 to 39.7 feet per mile, in the distance of 2½ miles; lines short, like those in Scioto county, an account of the difficulty in identifying strata at distant points.

Both the above statements must be received as local, and not general results.

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*The "line of dip" is the line of greatest inclination; the "line of bearing" is perpendicular to the line of dip, and is horizontal. All lines making an angle with the line of dip have *less descent;* and when that angle is known, the plunge, in a given direction, may be found thus: the greatest dip is to the dip on a given line, as 90 degrees is to its angle with the line of bearing.

ROSS COUNTY.

Line No. 1, up Paint creek, 4.23 miles; No. 2, Chillicothe to Waverly, 13.12 miles; No. 3, Lumbeck's quarry to Waverly, 11.55 miles; No. 4, Chillicothe, (point of hill), to Lumbeck's quarry, 1.96 mile; No. 5, from near Mr. J. Stinson's, section 21, T. 8, R. 19, Jackson county, to Strong's mill, 6.08 miles; No. 6, (furnished by A. Bourne,) from Waverly, 12 miles S.

Plane	of Nos.	1	and	2	Dip	S. 83½°	E.	31.99	feet	per	mile.
"	"	1	"	4	"	N. 74¾°	E.	26.40	"		"
"	"	3	"	5	"	S. 81°	E.	29.60	"		"
"	"	5	"	6	"	S. 60°	E.	30.	"		"

These lines, with the exception of No. 5, were traced at the regular and well defined junction of the fine-grained sandstone and slate formations.

No. 5 was taken in the valley of Salt creek, at the junction of the conglomerate and fine-grained sandstone, about 20 miles east of Waverly.

WAVERLY, PIKE COUNTY.

Some short lines in the quarries below Waverly, show a local *north westerly* dip in that vicinity, bearing N. 19½° west, 11.85 feet per mile.

FRANKLIN COUNTY.

Valley of the Scioto and Olentangy; meeting of the slate and limestone formations.—Of six measurments obtained here, but three are worthy of any credit, on account of the difficulty in tracing lines of stratification in the slate, and the irregularities on the surface of the limerock.

The longest line in the slate, is 994 feet, in the ravine at Kinnear's, 4 miles north of Columbus. The longest line in the limestone, is 10 miles. Mean of 2 planes, S. 81° 52′ E., 22.73 feet per mile.

ZANESVILLE.

Coal and limestone beds.—Mean of four planes, average length of lines, 1,200 yards, S. 87° E. 47.85 feet per mile.

TUSCARAWAS COUNTY, (CENTRAL PART.)

Coal and hydraulic lime beds.—Dip, S. 86° E. 9.9 feet per mile. To the north part of this county there is much unconformity in the strata. A line in the limestone near lock 11, N. 48° E. 2.7 miles, gave a northeasterly descent of 52 feet. Another in a bed of ore on the opposite side of the Tuscarawas, N. 38° E. 1½ miles, found to have 4 feet ascent.

PORTAGE AND TRUMBULL COUNTIES.

The base rocks of that portion of the Reserve east of the Cuyahoga, can scarcely be said to have a decided dip. From the falls of Mill creek, in Newburg, Cuyahoga county, to the Chagrin river, a line at the surface of the slate formation, N. 41° E. 15.3 miles, has a descent of less than 10 feet. From the Cuyahoga Falls, to near Warren, N. 76½° E. 34.6 miles, the difference of level in the bed of the conglomerate, is not 20 feet, all of which might be charged to local disturbance. Northwesterly of the latter line, there is an apparent inclination of the lower strata, in the direction of Elyria, but the *superior* surface of the conglomerate is *nearly level*. The coal measures do not conform to the rocks below. From Mr. Newberry's coal bed, at the N. W. Six Corners in Tallmadge, to a central point among the mines northwesterly of Youngstown, bearing east 41.2 miles, the descent is 185 feet, and thence N. 33½° E. 11.5 miles, to Gen. Curtis' coal opening in Brookfield, is an ascent of 162 feet, giving a general inclination of 20.6 feet per mile, in a direction S. 12½° E. for the lowest bed of coal.

General dip.—The surface of the slate formation near where the Sandusky river crosses the east line of Crawford county, is ascertained within a few feet, and is fixed at 184 above the same rock at Newburg, 75 miles distant, and 268 above it at Chillicothe, 101½ miles south. The mean dip thus shown is very slight, being S. 59½° east 5.4 feet per mile.

ANCIENT WORKS.

When in the neighborhood of antique remains, I have taken particular surveys of them, according to the plan spoken of in the report of last year. I have now collected materials for the delineation and description of more than thirty of these works, and about the same number remain to be explored.—It did not seem advisable, however, to present them till the collection shall have been completed.

MAPS.

Much time has been spent during the progress of the survey, in obtaining geographical facts, with a view to the ultimate publication of a State Map as ordered by the law of March 27, 1837.

A better occasion cannot be expected, to supply in an economical and thorough manner, the great deficiency of county maps. In addition to the usual geographical representations, they would embrace, in a plain and comprehensive form, much of the geological information elicited by the survey.

The accumulative expense would not, in average, exceed $150 per county. The estimates of Messrs. Doolittle and Munson, for engraving, predicated upon a scale of half an inch to the mile, and 1000 copies, are as follows:—The naked sheet, *nine* and *seven-tenths* cents

per copy; colored, thirteen and seven-tenths cents per copy; full set of the counties, bound, $12 75. The engraved plates remain the property of the State. Judging from the interest manifested upon this subject, the counties would willingly receive maps, and refund to the State Treasury their extra cost.

VARIATION OF THE NEEDLE.

The almost imperceptible, but never ceasing changes that occur in the magnetic meridians, which are observed wherever the needle has been carried, give rise to great uncertainty and perplexities in practical surveying.

Throughout the United States these meridians *converge* towards a line, crossing Lake Erie near the northeast corner of Ohio, and passing thence about S. 20° E., across western Pennsylvania, Virginia and northeastern North Carolina, to the Atlantic ocean, east of Newbern.

Along this line, the needle points to the *true pole; west* of it the departure from the astronomical meridian, is *eastward*, and *east* of it, always *westward*, in the United States.

A compass set up at the mouth of the Little Platte, on the Missouri, would show a variation of 11° east, and carried thence to the sources of the St. John's, in Maine, would veer gradually westward and finally settle at N. 17° W. moving over an arc of 28°.

The line of "no variation" has a movement *westward*, which works a continual change in the magnetic meridians.

In the years 1795–6, during the survey of the Holland purchase, in New York, the needle coincided with the line of longitude on the southern shore of Lake Erie, at the north line of T. 8, R. 9, on a meridian about 12 miles west of Buffalo.

In the year 1657, no variation existed at London, in England, where 77 years previous, the needle pointed N. 11° 15′ *east*, and in 1800, 24° 3′ 36″ *west*.

Professor E. Loomis, of the Western Reserve College, having collected and published in the American Journal of Arts and Sciences, vol. 34, a mass of facts concerning the fluctuations and present position of the needle in the United States, says in conclusion:

1st. "The *westerly* variation is at present *increasing*, and the easterly *diminishing* in all parts of the United States."

2nd. "The change commenced between the years 1793 and 1819, probably not every where simultaneously."

3rd. "The present *annual change* of variation, is about *two minutes* in the southern and western states, from *three* to four in the middle, and from five to seven, in the New Englad States."

An inquiry into the habits of an instrument so closely connected with the rights of property as the surveyor's compass, seemed to come properly within the practical intent of this survey.

By a circular letter to the county surveyors of this State, requesting them to take the variation on the 25th of July 1838, I have obtained considerable information, which, with that derived from other sources, particularly from the observations by Professor Loomis, is here arranged in order, the variations beginning at the least.

TABLE OF VARIATIONS.

Place of observation.	Lat. North. ° ′ ″	Lon. West. ° ′ ″	Variation. ° ′ ″	Date of observation, remarks, etc.	Name of observer.
Chardon, Geauga county,	41 35 11	81 5 00	— 15 e.	1838, July 26. 15 ms. south; variation 4′ 14″ at same date.	R. Cowles & W. W. Beals.
Carrollton, Carroll county,	— — —	— — —	— 30 e.	1838, August 17.	Van Brown.
Cleveland,	41 30 00	— — —	— 35 e.	1837–8 Winter.	Ahaz Merchant.
"	— — —	— — —	— 50 e.	1833–4 Winter.	Ahaz Merchant.
Cleveland,	— — —	— — —	1 20 00	1830, Oc. Betw'n 1830 & 1834, the needle did not change perceptibly; in Oct 1830, varied 30 min. in 3 weeks.	" "
Brookfield, Trumbull county,	41 14 00	80 37 00	— 40 e.	1837, September.	George Boyce
Braceville, Trumbull county,	41 14 00	81 3 00	— 50 30	1838 Mean of 9 morning observations between July 28 and October 13.	Franklin E. Stowe.
Euclid, Cuyahoga county,	— — —	— — —	1 30 00	1825–6—winter.	Ahaz Merchant.
Tallmadge, Portage county,	41 5 00	— — —	1 00 00	1806.	S. E. Ensign.
Portage, " "	41 00 00	— — —	1 00 00	1797.	Moses Warren.
" " "	— — —	— — —	1 15 00	1838, September.	Mr. Mallison.
Hudson, W. Reserve College,	41 13 00	81 30 00	1 14 00	1837.	E. Loomis.
Batesville, Monroe county,	— — —	— — —	1 22 30	1838, July 25 Variat'n betw'n 8 A. M. and 2 P. M. 15′.	M. Atkinson.
Marietta,	39 25 00	81 26 00	1 29 00	1838.	E. Loomis.
"	39 25 00	— — —	2 36 00	1810.	Jared Mansfield.
" six miles north,	— — —	— — —	1 36 00	1838, July 26.	B. E. Stone.
Coshocton,	40 28 00	81 56 48	1 30 00	1838, July 25.	John M. Sweeny.

TABLE OF VARIATIONS—Continued.

Place of observation.	Lat. North. ° ′ ″	Lon. West. ° ′ ″	Variation. ° ′ ″	Date of observation, remarks, etc.	Name of observer.
S. E. corner of the W. Reserve,	41 00 00	80 37 00	1 21 00	1810.	Jared Mansfield.
10 miles west, - -	41 00 00	80 50 00	1 37 00	" Mr. Mansfield was at this	" "
20 " " - -	41 00 00	81 30 00	1 48 00	" time on duty as Surveyor	" "
33 " " - -	41 00 00	81 21 00	2 4 00	" General of the U. S.	" "
43 " " - -	41 00 00	81 34 00	2 22 00	1810.	" "
Near Tuscaraws, 57 miles west.	41 00 00	81 53 00	2 30 00	"	" "
Near S. W. corner, 123 miles " -	— — —	83 20 00	3 57 00	"	" "
45 miles west of State line, - -	— — —	— — —	2 00 00	1797.	A. Atwater.
" " " - -	41 14 00	— — —	2 5 00	1821.	Ralph Cowles.
Wooster, Wayne county, - -	— — —	— — —	1 47 00	1837, December.	C. W. Christmas.
" " " - -	— — —	— — —	2 33 00	1831, November.	" "
Canal, Dover, Tuscarawas co. -	40 31 11	81 29 00	1 49 40	1838, July 3 & Aug. 2 Mean of 4 observations	Herman V. Beeson.
Sandy tp. Tuscarawas county, -	40 37 11	81 28 00	2 10 00	1810, May.	E. Buckingham.
Zanesville, - - - - - - - -	39 59 00	82 3 48	2 30 00	1838, July 25.	James Boyle.
Kalida, - - - - - - - - -	40 59 30	84 13 43	2 59 47	" " "	E. B. Fitch.
St. Clairsville, - - - - - -	40 10 00	80 51 48	2 31 00	1838, July 25,	James C. Moore.
	40 7 00	80 51 48	2 32 30	1837, October.	
	40 7 00	80 51 48	3 10 00	1820.	
Gallipolis, - - - - - - - -	38 53 00	— — —	2 35 00	1838, August 14,	Joseph Fletcher.
	38 53 00	— — —	3 40 00	1806, January 6.	
Lower Sandusky, - - - - -	41 21 00	83 09 09	2 48 13	1838, August 21.	David Reeves.
Flat Rock, Henry county, - -	41 18 00	84 12 48	3 13 41	1838, July 28.	Wm. C. Brownell.
Washington, Fayette county, -	— — —	— — —	3 5 37	1838, July 27.	Joseph Bell.
Jackson, Jackson county, - -	39 15 00	82 41 48	3 10 00	1838, August 1.	Oliver N. Tyson.

Athens, Athens county,	39 16 00	— — —	3 12 00	1838, July 25, 6 A M, Daily variation 14 minutes.	S. B. Pruden.
" " "	39 16 00	— — —	4 03 00	1796.	Public Surveys.
Spring Bank, Green county,	39 45 00	— — —	3 14 11	1838, Aug. 1. Between 1805 & 1817, the variation increased rapidly eastw'd	Moses Collier.
	39 45 00	— — —	4 54 00	1818, April.	
Chillicothe,	39 21 00	— — —	3 15 00	1835.	A. Bourne.
Marion, Marion county,	40 35 00	— — —	3 17 22	1838, August 2.	Samuel Holmes.
Maumee Rapids,	41 30 00	83 30 00	3 25 00	1810.	J. Mansfield.
Springboro, Warren county,	39 31 30	84 16 3	4 3 37	1838, July 25.	E. Baily, Jr.
	— — —	— — —	5 30 00	1820.	
Wilmington, Clinton county,	39 28 00	— — —	4 5 40	1838, July & Aug. Mean of 3 morn'g observations.	David Wickersham.
Wilmington, Clinton county,	39 28 00	— — —	4 25 00	1834, May. Mean of several morning observations.	
Fort Defiance,	41 15 00	84 23 00	4 30 00	1810.	Jared Mansfield.
Springfield,	— — —	— — —	4 30 00	1835.	Survey of National Road.
Cincinnati,	39 5 54	84 27 00	4 58 00	1806.	Public Surveys.
"	39 5 54	84 27 00	5 00 00	1810.	J. Mansfield.
Portsmouth,	38 48 00	82 50 00	5 00 00	1806.	Public Surveys.
Mouth of Great Miami,	39 8 00	84 45 00	5 10 00	1810.	J. Mansfield.
Kenton, Hardin county,	40 39 00	83 36 48	5 17 00	1838, June 25.	John H. Ross.
New Madison, Darke county,	39 56 00	84 36 48	4 51 00	1838, June & Sep. Mean of 9 obs'rvat'ns	Judson Jaqua.
" " " "	39 56 00	84 36 48	5 23 00	1826.	" "

It has, of course, been impracticable to reduce these observations to the same hour of the day, which leaves them liable to an extreme error of fifteen minutes. From this exhibition it is plain, as stated by Mr. Mansfield, that the increase of *eastern variation* and *west longitude* in this State, go *nearly* together; thus, the difference in longitude, between the east line of the State and Defiance, is 3° 46′, difference in variation, 3° 9′; between Marietta and Cincinnati, in lon. 3° 1′, variation 2° 2′ 4″, the latitudes differing about 15′.

The latitude and longitude of many places is of course obtained by the map, and liable to small inaccuracies.—Where longitudes were given from Washington City, I have changed them to Greenwich; making an addition of 5′ 10.98″ to the mean time given by former observations, (a correction introduced in the American Almanac for 1838,) which makes the longitude of Washington 77° 1′ 48″ west.

DIURNAL VARIATION OF THE NEEDLE.

Another habitual motion of the needle has been observed by philosophers, which fulfills its period every 24 hours, and is called the "daily variation."—At the solicitation of several surveyors, the facts now in my possession are made public. Under this influence, the motion of the north end is everywhere westward, (or from the rising sun); wherefore, in places having a permanent declination *westward*, the daily motion goes to *increase*, and when it is *eastward*, to *diminish*, the *general* variation.

The amount of deviation varies with the season of the year, being *greatest* in the *warm months*, and attains its *daily* maximum, as a general rule, about the hour of greatest intensity in the united heat of the air and the earth.

The observations I have at command, taken within the limits of this State, are few and not extended.

Franklin E. Stowe, surveyor of Trumbull county, has taken several at Braceville, in lat., by estimation, 41° 14′ N., and lon. 81° 3′ W.

Mr. Stowe's report is general, and gives the position in the *morning* at 1 P. M., and *evening*, by 9, 8 and 10, observations between the 25th of July and 13th of October, of this year, and is as follows:

Mean difference between morning and evening, 4′ 27″.
" " " 1 P. M. 10′ 57″.

Mr. D. Wickersham, of Clinton county, gives it at about 9′ 20″; Mr. Merchant, of Cleveland, 10′ to 15′; and Mr. Mallison, of Akron, at 10′—as near a coincidence as could be expected by a common instrument. But as there is a marked *uniformity* in these daily vibrations, the world over, I shall introduce a few foreign observations.

According to the observations of Professor Loomis, at New Haven, 1834–5, (during 13 months,) the day *minimum* occurred at 8 A. M., with the exception of May, June, August and September, when it came at 7, A. M.

The day *maximum* for May, June, July, August and September, took place at 1, P. M.; for March, at 3, and the other months, at 2, P. M. The experiments of Professor A. D. Bache, at West Chester, Pennsylvania, between the 29th of August and 7th of September, 1832, go to show a *mid-night*, as well as a *mid-day* maximum.

I insert a table of the mean daily traverse of the needle, for each month in the year.

TABLE,

Showing the maximum of daily variation for each month.

MONTHS.	1835. New-Haven, Prof. Loomis.	1817-8-9. England, Col. Beaufoy	1793. England, Mr. Gilpin.	1787. England, Mr. Gilpin.	1759. England. Mr. J. Canton.
	′ ″	′ ″	′ ″	′ ″	′ ″
January, -	4 27	5 3	4 18	10 12	7 8
February, -	2 52	6 3	4 36	10 24	8 58
March, -	5 25	8 22	8 30	15 00	11 17
April, - -	7 33	11 48	11 42	17 24	12 26
May, - - -	12 10	9 53	10 24	18 54	13 00
June, - - -	11 11	11 15	12 36	19 36	13 21
July, - - -	10 3	10 43	12 30	19 36	13 14
August, - -	13 30	11 26	12 6	19 24	12 19
September, -	14 3	9 44	9 48	15 30	11 43
October, - -	10 39	8 46	7 00	14 18	10 36
November,	Mean of 2 y'rs. 6 15	7 10	3 48	11 6	8 9
December, -	3 9	4 7	3 48	8 18	6 58

The general correspondence of these observations, authorizes an inference, that the intensity of the disturbing cause is not materially affected by distance, or time, and that we may safely apply the above results here. The cases given by our own surveyors, confirm this opinion.

The column for 1787 is to be suspected, on account of its excess over all the others; but the relative deviation for the months when compared with each other, is similar to that of other year's.

ACCIDENTAL DISTURBANCES OF THE NEEDLE.

When all the corrections for general and diurnal variations are made, there are still sources of error in the use of the magnet for the establishment of lines. It is well ascertained that temporary agitations and deflections of the needle occur during atmospheric changes, as rain, clouds, fogs and wind.

The electrical action of thunder storms, and more particularly the meteorological phenomena of the aurora borealis, are sure to disturb it.

It is recorded of an aurora that was observed, February 28th, 1750, that the needle vibrated from 6° 50′ west, to 9° 1′, and on the 2d of April, (same year,) it oscillated between 4° 56′ and 9° 55′ from the same cause.

Between half past 11 o'clock P. M., November 17, 1835, and 7 A.M. November 18th, during a brilliant display of the northern lights, Professor Loomis observed a change at New Haven, from 5° 12′ to 6° 53′ west, or a motion of 1° 41′ in 6½ hours.

His observations were numerous, and led to the remark, that an aurora occasions "almost always a deflection of 10′, 20′ or 30′, and in two instances, of more than a degree."

During a shower, unaccompanied by thunder or lightning, on the 31st of August, 1832, Professor Bache saw the needle move from 3° 26′ 30″ west, to 3° 10′ 42″, or 15′ 48″, in a short time. The extreme movement during 9 days, was 24′ 3″

Mr. Stowe found the extreme difference of six observations, between July 14 and October 21, 1838, to be 30′, and for one day 19′.

Mr. V. Brown, surveyor of Carroll county, relates an instance of a stubborn deviation of the needle for several hours, during a thick fog and haze, after a severe rain, amounting to half a degree.

These perplexing irregularities overcome the regular variations, and render the needle useless for the time. When no *apparent* cause presents itself, the surveyor may rest satisfied of the presence of an aurora whose feeble radiance is obscured by the light of the sun, or of the moon; or otherwise, of some unusual activity among the electrical agents.

The above facts relating to the character of the magnet, are not to be considered as complete. They are made public at this time, with a view to awaken the attention of surveyors to its mysterious wanderings, and in the hope that they will observe more frequently, and record more minutely than they have done.

I solicit their assistance in collecting the materials for a magnetic chart of the State. It is also my intention to establish a true meridian line, near the seat of justice for each county.

HEIGHT OF WATER IN LAKE ERIE.

Pursuant to your request, I have collected some facts relative to fluctuations in the surface of the lake.

A late rise which threatened much damage to lake property, did not fail of attracting attention, and exciting speculation, yet exact statistics in feet and inches were with difficulty obtained. I present the niformation, however, as of the best character the nature of the case admits, hoping that those acquainted with the lakes, will assist me to correct and enlarge it at some future period.

The highest permanent state of Lake Erie in the present year,

which occurred between the 20th and 30th of June, is made the zero of reference.

The surface corresponded at that time, very nearly with the lower edge of the upper course of masonry, along the south end of the eastern pier at Cleveland. This work is laid upon piles that have stood many years, and promises to be a fixed and enduring monument.

The matter is arranged according to dates. Where no measurements were to be had, I have given the mean of the supposed heights by different observers, which are distinguished by a star.

DATE.	DEPRESSION.	REMARKS.
1796 - - -	- - - -	From Buffalo to Cleveland beach about 100 yards wide.
1798, - -	- - - -	Higher than 1796.
1802, - - -	- - - -	Reported lower than in 1822.
1806, - - -	- - - -	Low.
1810–11, - -	*6 feet, - -	
1813, - - -	- - - -	Rose.
1814, - -	- - - -	Rose 2 feet 6 inches in 3 months.
1815, June, - -	*5 feet, - -	3 feet rise.
" latter part, -	*2 " - -	
1816, early, - -	*2 " - -	Rise of last year still continues.
1819, late in summer,	*6 " -	Probably lower. The y'rs 1815–16–17 are reported wet; 1818–19 very dry.
1822, - - -	*5 " - -	Probably more.
1825, - - -	4 " - -	General level.
1826, - - -	2 feet 10 inches, -	" "
1832, - - -	2 " 6 & 3 ft. 2 in.	Greatest difference observ'd, 8 in.
1833, - - -	3 ft. 8, low'st stage	Highest stage, 2 ft. 8 inches.
1834, June, - -	2 feet 7 inches.	
1835, " - -	2 " 10 "	
" September, -	3 " 4 "	
1837, January, -	3 " 1.2 "	
" June, - -	2 " 7 "	
" September, -	3 " 6 "	
1838, May 10, -	1 " 0 "	
" June 12, -	0 " 4 "	Floods arable land.
" " 25, -	0 " 0 "	Greatest known height.
" July 12, -	0 " 3 "	
" August 18, -	0 " 9 "	Between these dates, Mr. Geo. C. Davis, of Cleveland, kept a daily register which he has placed at my disposal.
" October 18, -	1 " 9 "	
" December 1, -	1 " 11½ "	

The mean depression of each week is here given, in inches and hundredths.

August 24th, 9.29; 31st, 10.43. September 7th, 13.07; 14th, 13.57; 21st, 15.57; 28th, 16.29. October 5th, 18.00; 12th, 19.00.

This shows a continual advance of the waters since 1819. In re-

gard to the other lakes, *Ontario* stood at six feet ten inches above the level of 1825, in August of this year. *Michigan* was said to be over six feet higher in the present June, than it was about the year 1820, and has never been as low since.

Lake *Superior* is reported to have been three feet higher than usual, and one foot above last year. The rivers St. Clair and Detroit experience about the same change as the lakes they connect.

The depression exhibited by the table of Mr. Davis is due to evaporation. American authorities relative to the escape of water by this cause, are not in my reach; but the observations of Dalton and Hoyle, at Manchester, in 1796–7–8, give a loss of eighteen inches for the period of four months from the 18th of June. In this case, we have in addition to the supply of tributaries and rains, twenty-one inches for the same length of time. The falling water of the clouds during this period, could have been but very little, probably less than two inches. This continued drought almost dried up the rivers that discharge into the lake, (excepting the Detroit,) so that all of them could not furnish over two inches, which will give twenty-five inches of water, carried off in vapor. I assume that the inlet at *Malden* is equal to the outlet at *Black Rock*, without, however, any measurements to verify the supposition. The influence of dews is also neglected.

The general belief among navigators, and residents upon the lakes, appears to be uniformly against the existence of any *law*, by which these fluctuations are governed, or may be predicted. The scanty information here collected, tends to the conclusion, that these general elevations and depressions are *fortuitous*, and the result of accidental disorders in the seasons, throughout the lake country.

It is, however, well established, that there is in lake Erie an *annual tide*, independent of the general stage of water, which varies from 8 to 15 inches, in the mean.

The minimum, occurs about the time of the breaking up of ice, late in winter, and the maximum, late in spring, or early in summer. The water subsides rapidly during the summer and fall. In the winter less change is perceptible; but early in the spring it rises very fast, and with great regularity, till it reaches the maximum. All measurement should be taken subject to this change; but I am unable to fix upon a mean surface for the year, or to give the probable error.

The geographical position of lake Erie in reference to prevailing winds, is the cause of irregularities in the *annual* rise and fall of its waters. Its general course being northeast and southwest, discharging at the north, the steady westerly winds of the fall accelerate the flow of water *from* this lake, at the same time *retarding* its supply from the other lakes.

DAILY TIDE.

It has been asserted that there existed in the lakes, as in the ocean, a daily or lunar tide. Whether it is true when applied to Huron, Ontario, and the other lakes, is not perhaps entirely settled. The

observations I have been enabled to make on lake Erie, and the uniform testimony of watermen, and harbor workmen, coincide in denying the existence of any change resembling the oceanic tide. But the following extract from a recent letter of Mr. Davis, is the strongest testimony to the point. Speaking of the presence of a daily tide, he says: "This is not the fact. The examination of the tide waiter kept at our office, and observed almost hourly since August, enables me to assert without fear of contradiction, that there is no tide upon Lake Erie."

ENCROACHMENTS UPON THE SHORE.

When the first settlers of the Western Reserve came along the Ohio shore, in 1796, the sandy beach of the lake was occupied as a road throughout, and was used for that purpose east of Cleveland many years.

At the present time, the encroachment upon surveyed lots, between the Cuyahoga and Chagrin rivers, is from 10 to 20 rods.

If we except a short distance along the shore west of Conneaut harbor, about 5 miles next westerly of Fairport, and 20 miles rock coast between Cuyahoga and Black rivers, the entire shore from the State line to the lime rock near Huron, has lost an average of 8 rods in width. The immediate bank is composed of loose earthy materials incapable of resisting the action of the waves, with the above exceptions.

At the debouche of the streams, the most valuable commercial sites are subject to inundation. From the mouth of Sandusky Bay westward and northward, around the end of the lake, and along the Maumee river, and all other streams discharging into the lake, or the Detroit river, the country adjacent to the water is but little elevated above its (heretofore) ordinary surface. Consequently it has gone inland, over cultivated grounds and upon tracts of land, where the forest had attained its full growth, since the occurrence of a similar flood; if indeed it ever occurred.

In a matter so deeply affecting the health and fortunes of the lake population, it would be gratifying to be able to arrive at some conclusion in regard to its return. The present season presents an extreme case, and the probabilities are, therefore, against its recurrence, to the same extent.

The rapid evaporation of the past summer and fall, has reduced it nearly to the level of preceding years, requiring an unusual fall of snow and rain, in the present winter and coming spring, to bring it back to the maximum of this year. When we consider the force of evaporation, and the quantity of falling water upon a given surface, there is reason rather to be surprised, that the changes in our inland seas are not greater than we observe, than that they should rise and fall a few inches or a few feet. Destroy the counteracting effect of vaporization, and the rains will elevate a perfect reservoir, about 33 inches in a year, without any other supply. Cut off the supply from the heavens, and elsewhere, and expose it to the unchecked

action of the sun and air, and it will sink about 44 inches in the same time. In small bodies of water, where there are not, as in the ocean, equalizing under currents, a slight deviation from the ordinary course of the season must produce a visible effect. On the lakes there are periodical winds and local positions, that may at times act in favor of the other irregularities, as well as against them. Under these circumstances, a perfect equilibrium between rains and evaporation would be a remarkable occurrence.

GEOLOGICAL REPORT.

According to your directions, I have examined the coal region of Trumbull and Portage counties.

Any attempt to do justice to a geological representation, without the aid of maps, must necessarily fail of success; but the limited extent of country embraced in this description, did not seem to warrant the expense of an engraving for the *annual* report.

Much time was necessarily directed to the rocks below the coal, cropping out between the coal region and the lake; but they were not sufficiently studied to receive a detailed notice at this time.

TOPOGRAPHY OF THE REGION.

That portion of the Reserve, east of the river Cuyahoga, is, in its general surface, almost level. A comparison of heights between the most elevated parts will exhibit this striking uniformity.

The highland in Portage township, is above Lake Erie about 600 feet; Tallmadge, 625; Hudson, (College,) 547; Aurora village, 575; Mantua, (summit of Chagrin and Cuyahoga rivers,) 626; Burton Center, about 650; Little Mountain, 600; Brookfield (east part,) 590; Conneaut Lake in Pennsylvania, near the northeast corner of Ohio, 509; Ravenna, (about) 560; Edinburg, (about) 620.

Those townships along the south line, apparently maintain a level of 500 to 600 feet, and the highest points upon the east line of the State, range about the same till we approach the lake.

Both the general and local ridges of highland, have a northerly direction. A large valley or depression in the country, having a level of about 300 feet above the lake, occupies the northwestern part of Trumbull, and westerly portion of Ashtabula counties, with the Grand river in its centre. The Mahoning enters it at the southwest, passes across the southern end, and leaves it at the southeast.

Range 8 occupies about the middle, or highest portion of an elevated tract stretching north and south across the Reserve, its eastern slope overlooking the valley just named.

The Cuyahoga passes through this ridge, from the eastern to the western face, between Hiram and Shalersville. This stream continues southward, near the Portage summit, and making a detour to the north, seeks the lake through a valley west of the ridge.

All the important streams discharging into the lake, from the ter-

ritory under consideration, seem to have been arrested in their direct course by some general cause. A few miles from the shore they change direction to the westward, and run considerable distances nearly parallel with it.

The general level of the country holds out in a northerly direction till we arrive within about five miles of the Lake, when it suddenly sinks to within about 150 feet of its surface.

The bluff thus formed has the appearance from the lake side, of a mountain range, and behind this apparent elevation the streams take their westerly course.

It is however little more than the crest formed by an abrupt descent from an elevation of 300 and 400, to about 100 or 150 feet above the lake, and is the limit of the immediate basin of lake Erie. Beneath it a belt of flat land stretches right and left along the shore, from the Cuyahoga to the State line, offering no impediment to a full view of the waters beyond.

LAKE RIDGES.

This strip of low ground descends from the foot of the bluff, imperceptibly, towards the lake, and is marked by slight ridges, or a succession of low, gentle undulations, like a broad turnpike or wave running parallel with the shore.

They vary in number, from one to three, and are distant from the water's edge, from half a mile to five miles. In general, they represent an offset or terrace of a few feet from one level to another, and are composed of sandy materials. They do not appear to be upon an exact longitudinal level, differing in height from 90 to 120 feet above the lake. They bear away more inland as they are traced westward into the counties of Huron and Sandusky.

Between these natural roads and the shore, the soil is mostly of a *sandy* character, and back of them to the foot of the bluff, the *clay* predominates. All these circumstances have led to a general belief, that the waters of lake Erie once stood an hundred feet higher than at present, and that the bold front which now presents itself, formed the ancient shore.

External appearances certainly indicate such a state of things, but there is not, as yet, evidence enough to decide this interesting question. It would be difficult to find natural barriers for a sea which should have elevated itself to that height.

The summit between lake Erie and Lockport, is 25½ feet above the former, and the highest ground observed between Porter's warehouse, on the Niagara, and Lewiston, in the survey for the ship canal, is 75½ feet above the same level.

From these summits, the way is open to the Atlantic, east and north. On the west, the summit between lake Michigan and the Illinois river, is 25 feet above that lake, and 79 higher than lake Erie, according to general report.

Owing to the great uniformity of natural surface, opportunities of inspecting the strata occur but seldom, and at points distant from each other.

The rocks, unless denuded by water courses, are clothed with heavy deposits of unstratified materials, having distinct marks of agitation and transportation by water. This loose matter occurs to the depth of 100 feet, forming distinct hills, and filling up vallies. It is composed of pebbles of quartz, granitic rocks, limestone, sandstone, iron ores, hornstone and shales, interspersed through clay and sand.

The central portions of some of these diluvial hills, are constituted of *pure sand*, while the external coating is of *clay*, to a depth of 10, 20, or 30 feet.

The primitive "boulder," or "lost rock," is scattered over this country in profusion, and in very large blocks.

General view of the rocks, from Lake Erie, (east of Cleveland,) to the south line of the Reserve. See also the engraved section.

Order of strata	Formation.	Thickness in feet.	Place of observation.	Elevation above Lake Erie.
1.	Slate and shale, with thin bands of iron ore	Prob'bly 400	Newburg, - -	- - 190 feet.
			Willoughby, -	About 180 "
2.	Fine grained sandstone & shale with bands of sandstone and ore.	25 to 80	Newburg, - - -	- - 275 "
			Cuyahoga Falls,	- - 360 "
			Boston, - - -	- - 178 "
			Warren, - -	- - 330 "
3.	Coarse grained sandstone, includ'g conglomerate and the intermediate shale.	10 to 300	Cuyahoga Falls,	- - 450 "
			Burton, - - -	About 650 "
			Akron, - - -	" 600 "
			Brookfield, - -	- - 500 "
			Youngstown, -	- - 342 "
			Garretsville, -	- - 425 "
			Mantua, - -	About 650 "
4.	Coal series compos'd of sandstones, shale, limest'ne & iron ores		Poland, - - -	About 600 "
			Tallmadge, -	- - 625 "
			Brookfield, - -	- - 590 "

The dip of these strata is stated in a former part of the report. The dark shale of formation No. 1, is simply the equivalent of the slate, and contains numerous thin beds of rich argillaceous ore, never exceeding 3 inches in thickness, and therefore of little or no value.

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Order of strata	
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Its upper surface is quite uniform and well defined, affording excellent opportunities for the calculation of its dip. It forms but a small portion of the surface rock, cropping out along the eastern side of the valley of the Cuyahoga, and thence, turning easterly at Newburg, constitutes the body of the bluff which overlooks the lake.

FORMATION NO. 2.

The character of this member is very changeable, as is shown by the following sections in the ascending order, made at different points.

1st. At Newburg, (near Kingsbury's,) resting on slate, fine-grained, compact, blue sandstone, 25 feet, with ripple marks.

This bed furnishes building and flagging stone of a good quality, and is extensively quarried for use, and also for exportation. It splits with the greatest precision.

Black shale and sandstone, in thin layers, 10 feet; soft red shale, 30 feet, overlaid by coarse sand rock.

2d. Big Brook (southeast part of Orange) 12 miles distant; rests on slate. Shale, with thin bands of hard sandstone, 25 feet; hard, close, sandstone, one and a half feet. Shale, with bands of sandstone, 20 feet; fine-grained sandstone, 2 feet. Shale, 12; hard, close sandstone, almost quartz, 1 foot. Shale, 20; overlaid by coarse sand rock.

On the surface of these layers, imperfect fucoides are seen, and in one near the top, an abundance of very perfect bivalves.

3d. Peninsula, Boston, 18 miles south by east. Shale, with bands of soft, fine sandstone, 30 feet; fine-grained sandstone, with shale between the layers, 20 feet; dark shale, with layers of ore, 15; overlaid by coarse-grained sandstone.

At Cuyahoga Falls the conglomerate rests upon this formation, its surface having risen over 100 feet. It here contains a bed of hydraulic lime 8 inches in thickness.

FORMATION NO. 3.

Section at Chagrin Falls, southeast corner of Orange township, T. 7, R. 10.

1st. Coarse-grained yellowish sand rock; no pebbles; imperfectly stratified; 40 feet.

This bed caps the height of land seen from the lake for several miles east of Cleveland, overlying the quarries of fine-grained sand stone, and is, in places, a good grindstone grit.

Ash colored shale, 15 feet; loose sand rock, partly in layers, 6 feet; shale, (ash color,) with layers of sandstone, 60; conglomerate, with large pebbles, 100; surface rock.

2d. Brandywine Mills, 14 miles southwest; coarse-grained sand rock, resting on fine-grained do. 15 feet; light colored shale, 25; conglomerate to surface.

3d. Parkman, R. 6, T. 6; conglomerate, resting on shale, 150.

4th. Cuyahoga Falls, conglomerate, 100, (at the edge of the coal series;) through 20 feet of the lowest part, pebbles very large and plenty, especially in the seams of the rock.

The inferior surface of the pebbled sand rock is quite regular; and its dip, ascertained by this face, has about the same uniformity as the subordinate strata. In the township of Portage, however, it pitches rapidly eastward, at the rate of about 60 feet per mile. It is the surface rock over a large part of Geauga county, the northern and western part of Portage, southeast portion of Medina, and northeastern part of Trumbull, and the irregularties of its superior face, are indicated by the local topography of these parts.

The channel of the Cuyahoga is in the conglomerate, from Burton to Cuyahoga Falls. It does not, in general, quarry well, and undergoes great changes in its external characters, in short distances.

This rock does not appear to be sufficiently compact for millstones, where it has been hitherto seen. When it approaches the coal series, its general thickness diminishes, and along the Mahoning, to a very few feet, where it is at times almost lost.

This explains the discrepancies between the natural and geological heights in the above table. The plunge of strata passing under the coal, is not sufficient to account for it, but the loss of thickness from the surface of the conglomerate, allows the coal deposits to take a lower position, occupying its place in the natural level.

FORMATION NO. 4.

The survey of the coal series, in a region where so few opportunities occur of direct observation upon the rocks, cannot be considered complete, till the earth is occasionally penetrated by borings at distant points. And on account of heavy masses of diluvial, or superficial matter, the outcrop of thin beds, like coal and iron, is often covered for many consecutive miles, and at unknown depths.

The composition of this formation is changeable; sandstone suddenly passing into shale; and shale changing to sandstone with equal readiness.

The thickness of the inferior beds, *varies* very much, (with the exception of the limestone,) and the thin strata of its upper portion frequently disappear entirely, and are replaced by other rocks. An inspection of the engraved section will furnish a tolerable idea of its general structure.

OUTLINE OF THE COAL REGION.

The western edge of the lowest bed of coal crosses the south line of Medina county in the south-easterly part of the township of Wadsworth, T. 1, R. 13. The bed occupies several hundred acres in the south part of Norton, west of the Tuscarawas, and south of Wolf creek; 3 to 4 feet thick.

The immediate valley of the Tuscarawas, and the Summit Lake, lies beneath this stratum, and where it would otherwise make its appear-

ance further east, in the township of Coventry, there are heavy beds of loose earth, which conceal it. A line, representing the general outcrop of this bed, would cross the northwest part of Springfield, T. 1, R. 10, and over the Little Cuyahoga, bearing northward from De Haven's mine, around the high ground, into the valley of Gamp Brook, to Long Swamp, and up the eastern side of this marsh towards the Cuyahoga; thence north-eastwardly, along the edge of the valley of that stream, towards the northeast corner of T. 2, R. 10.

Between this point and Shalersville, T. 4, R. 8, 10 miles northeast, sand and gravel hills occupy the ground where otherwise coal might be sought.

The bed at Shalersville being but 12 to 18 inches in thickness, and of an inferior quality, did not seem to demand a minute exploration. It may be found in thin beds near the surface along the highland, in the northern part of Freedom, south-easterly portion of Mantua, and southwest quarter of Windham, R. 6, T. 4.

The country here begins to descend easterly, and the general direction of the line of outcrop is south, about 25 degrees east, through the township of Paris, T. 3, R. 6, passing above the valley of the west branch of the Mahoning, into the township of Palmyra, north of the centre; thence it inclines easterly, around into the valley of Kale Creek, striking the south branch of Mahoning near Fredericksburg, in the south part of Milton township, T. 2, R. 5. The thickest beds between Shalersville and Fredericksburg do not exceed 20 inches.

From Fredericksburg north, towards the Centre of Milton, thence across to the valley of Duck Creek, near the north line of the township, there are indications of coal, but it is probably too thin to be of value.

Across the southern part of Lordstown, it is difficult to say where it might be found. Striking across the valley of the Big Meander Creek, it appears again in the eastern part of Jackson, T. 2, R. 4, in a workable bed of 2 feet, about 60 feet above the stream.

The mines opened on the opposite or eastern side of Big Meander, at the distance of one-half to three-fourths of a mile from it, in the west part of Austintown, measure from 2 to 4 feet. The bed here sweeps northward, around the highland in the southern part of Wethersfield, T. 3, R. 3, into the trough of the Mahoning river, having a thickness of three feet.

Along this river, and the ravines leading to it, the coal shows itself on both sides, at an elevation of 50 to 80 feet above its channel. It passes above the village of Youngstown, through the hill in rear, to the valley of Crab Creek, and soon goes under the high township of Coitsville.

Its northern outcrop, from Dunn's mine through the township of Liberty, T. 3, R. 2, owing to disorders in the stratification, is not satisfactorily determined. It occurs in a thin bed in the northeastern part of this township, extending easterly to the valley of Little Yankee Creek, in Hubbard, and the southeastern part of Brookfield, T. 4, R. 1, sometimes of a workable thickness.

This stream lies below the coal, which comes to the surface at the distance of ½ to 1½ miles from it, on the south, through the township of Hubbard, but is generally too thin to work.

North and east of the creek, it underlies an oblong tract of highland, beginning one mile south of the north line of Hubbard, and extending northwesterly, past the centre of Brookfield, averaging one mile and one fourth in width.

Coal, 1 to 3 feet thick, and very much contorted.

The stratum is here quite elevated above the streams, approaching the summit of the hills. In the northeastern part of Brookfield, and southern part of Hartford, east of the Big Yankee, it passes through a ridge between that creek and the Shenango river, occupying at least twelve hundred acres in an irregular form.

This bed is from 3 to 4½ feet thick, of a superior kind, well roofed, and uniform in dip and quality. On the State line, 2 miles north of Orangeville, in Vernon, T. 6. R. 1, the summit of a hill appears to contain a few acres of coal, which is the most northerly point of discovery within the State of Ohio.

By tracing this general outline on the map, and referring to the topography of the country, it will be seen to curve, first northward in the highlands of Portage county, returning southward in a sinuous and irregular course; as it enters the valley of the two branches of the Mahoning, again bending northward, over the ridge between them and Meander creek.

Thence, running up that stream on the west side, and down on the east, it crosses to the main Mahoning, above Youngstown, and making a rapid flexure northward, over the heights east of Musquito creek, passes into Pennsylvania about 40 miles from the lake.

This is to be considered as merely the edge of the great coal field of western Pennsylvania and eastern Ohio.

IMPORTANT BEDS OF COAL.

The valuable beds of this region, are mostly confined to the townships of Tallmadge, Austintown, Youngstown and Brookfield.

A detached hill, one mile west of the centre of the first named place, overlies at least 500 acres of accessible coal. It is somewhat undulating, varies in thickness from two to five feet, and cokes well.

The shale and sandstone roof contains an abundance of vegetable fossils, specimens of which, are in the cabinet.

The hill near De Haven's, in Springfield, promises to be a valuable mine, if properly worked.

In Austintown, the beds are of a good thickness, and the quality o. the coal not inferior.

But the strata are subject to continual distortions, forming basin-shaped cavities, that, sometimes, sink 20 feet in a less number of rods. These local irregularities overcome and often reverse the general dip, prohibiting all calculations relative to the drain and direction of the drift.

The same unfortunate disturbance exists in the beds along the Mahoning, in Youngstown and Poland. This coal, for household purposes, is of an excellent quality, and capable of producing coke in ovens.

In the valley of Mill creek, it thins out to a depth of only 8 to 18 inches, increasing to two feet near Baldwin's Mill. But it frequently attains a thickness of 4 feet, and if well stratified, would, from its location, be of incalculable value. As it is, the business of mining must ever be precarious, and the worth of a bed cannot be settled till it is explored by borings, or actually worked.

In the southwest part of Brookfield, the beds again show a sufficient depth for profitable operations, but the curvations of the strata are greater than upon the Mahoning.

This is the cause of a continual change in thickness, which is liable to disappoint the expectations of the miner at any moment.

If the local depression is large, the central part has the full amount of coal, thinning out more or less in all directions towards the edges. How far this difficulty exists throughout the hill, south of the centre, it is not easy to predict. But it seems to be entirely overcome when we cross the next valley, to the neighborhood of Sharon; and probably some parts of the ridge may be regular enough to be advantageously worked.

The quality of the coal is much more liable to changes in the same mine when the bed is warped, than otherwise. The mineral produced from the openings in the east part of Brookfield, burns clear, leaving very little residue, and may be manufactured into coke.

OTHER LOCALITIES.

There are many other points along the border of the coal region, where, although the bed is thin and irregular, the wants of the vicinity may be supplied by stripping.

The coal strata of the series, represented in the section as lying above the sandstone, are sometimes capable of being worked in this manner. A thickness of one foot will often justify the removal of two feet of earth.

The different localities of the upper beds, cannot be well represented without a map, and must be referred to in general terms.

Along the east line of Atwater, on Yellow creek, there are two strata, measuring from one foot to three feet in thickness, quality variable, and beds limited. A stratum of some local value, crops out along the dividing line of Ellsworth and Canfield; 18 inches to 3 feet in depth.

It occurs one mile southeast of the centre of Canfield; also about one and a half miles a little north of east; again, near the northeast corner of the township, and occasionally through the north and south parts of Boardman; from 1 to 2½ feet thick. Three of these upper beds crop out in the township of Poland, and the adjoining county south.

The uppermost coal deposit has a depth of 18 to 30 inches, medium

quality, and doubtless becomes a valuable stratum a few miles farther south. The other beds, lying above the sand rock, do not exceed two feet.

Coal is also found in the high ground at the northeastern part of Springfield, in Berlin, north of the centre, and also two miles south of the same place, in the southeast part of Deerfield, and many other places along the southern tier of townships, underlying large tracts of country, but too thin to be worthy of much attention.

The coal of all the upper beds, is inferior, and changeable in character, apt to crumble, slaty, and often pyritous.

COKE.

The different qualities of bituminous coal are *coked* with greater or less facility, by some known process. When the bitumen is abundant, which may be known by a tendency to melt and consolidate in the grate, it may be charred or coked in the open air, like wood; taking care to rake it apart as soon as the fire has passed through.

The Tallmadge coal undergoes this process in the open air, without any covering, but it is more economical to use close ovens, in which the refuse and inferior coal may be reduced.

It is in this form, that the great consumption of coal may be expected.

Coal that is offensive or injurious in the parlor, by reason of an excess of bitumen or sulphur, may be thus rendered a safe and pleasant fuel.

It is ascertained by experience, that a given quantity of mineral coal produces the *same degree of heat* on the blacksmith's fire after it is charred, that it would have done before, and in much *less time*. Coke is already in general use in the cupolas throughout the northeastern part of the State. But the great demand for this article, must soon come from the manufacture of *pig metal*.

The process of reducing ore with it in England, has been long known, and was remarked upon, in connexion with the hot blast, by Dr. Hildreth, in his preliminary report to the legislature.

Through the enterprise and perseverance of Mr. Peter Ritner, of Karthause, Clearfield co., Pa., the same practice has been introduced into this country, and at the last information, was in most successful operation. His experiments were made in a common charcoal stack, 45 feet from the hearth to the trundle head, diameter at the top, 6 feet, at the boshes, 13. Hearth 2 feet 6 inches square. Coke from the Phillipsburg coal was used in the operation, the details of which, relative to consumption, blast, product, &c., have been freely and *unreservedly* given me by Mr. Ritner.

Bushels of charcoal necessary to make a ton of pig, 200; bushels of coke, 75; charge of coke, 10 bushels; weight, 45 pounds per bushel; burthen, about one-forth the charge in weight; blast; 4,000 to 6,000 cubic feet per minute, under a pressure of 2¼ to 2½ pounds to the square inch; yield of furnace, 65 to 70 tons per week; ordinary yield

of charcoal stack, 23 to 27. Mr. R. says, under date of August 25, 1838, "as to quality, there can be no doubt of its being as good as that made from coke, in any part of the world. It has been tested by the committee appointed by the Treasury Department to try the strength of boiler iron, and bore 68.869 pounds to the square inch. We have also caused it to be rolled into bars and plates, and find it an excellent article. Finished bar iron can be made in this region, at a cost *not exceeding* $35 per ton, and I hope to see the time when it will be."

I am informed of another furnace at Kittanning, Armstrong co., Pa., now in operation with coke as a fuel.

LIMESTONE.

The want of value in the upper coal beds, is in some measure compensated by the limestone strata interspersed among them.

This rock exists in the greatest abundance through the southern townships of Trumbull county. The section at Poland exhibits three distinct beds in the vertical distance of 130 feet.

The uppermost one is of a light gray color, about 20 feet thick, incapable of furnishing quarry-stone, but produces quick lime of a good quality and tolerable *whiteness*. Its main development is seen further east, in Pennsylvania; only a patch of it crowning the heights west of the Mahoning.

About 100 feet below this, we meet a hard, blue, brittle, compact limerock, 2 feet thick, capable of polish, but not of being quarried; its quick lime is dark colored.

From 20 to 30 feet beneath this, occurs a third bed of about the same thickness, and with similar physical characteristics. In the upper bed, and at the lower surface of the lowest, the usual lime fossils are very numerous and distinct.

In the ravine on lot 53, Poland, is a bed of calcareous shale, with myriads of fossil remains, 6 feet thick.

Between these limestone beds there are seams of coal, sometimes thick enough to furnish a convenient fuel in the burning of lime.

The inclination of these beds is, apparently, east, about 20 feet per mile; but the limerock is not conformable in position, or uniform in dip. It is not unusual for these strata to disappear suddenly, so they do not always underlie all the land which is within their proper range.

This want of continuity renders it difficult to decide upon the identity of strata, at places not very distant from each other.

A bed of the same rock, (doubtless the lowest,) with coal beneath it, extends across the northern part of Boardman, to the northeast corner of Canfield; 18 inches to 2 feet thick.

A calcareous deposit passes over the coal at an opening east of Canfield Centre; but three-fourths of a mile southwest of the mine, it appears only in fragments.

Again, in the northwestern part of the same township, large blocks make their appearance near Mr. Beardsly's, leading to a regular bed, three feet thick, where the Palmyra road cross the west line. This con-

tinues southerly, to the East and West Centre road, in Ellsworth. It will probably be found on a line curving southwardly to the falls of Meander creek, descending, here, rapidly to the southwest.

Two valuable deposits are well known in Austintown, one mile west, and one and a half miles northeast of the centre. The easterly bed differs from the hard blue stone, in color and structure, and seems detached from its kindred strata.

On the middle of the south line of Liberty, is a field of blue limestone three feet thick, of indeterminate dimensions, extending southward, into Youngstown, three-fourths of a mile.

The hill northwest of Mogadore, in Springfield, contains a stratum three feet thick, near the summit. Its extent is indeterminate; but exists at least one mile south; its quick lime of a brown color.

In Freedom, there is a limestone ridge about one and a half miles in length, running north and south along the eastern line of the westerly tier of lots, south of the east and west road.

This stone furnishes a lighter colored lime than usual, contains a fine collection of fossils, and occupies about 200 acres on the summit of the ridge. The same bed extends westward, across the valley of one of the branches of the Mahoning, and passes through an eminence one and one-fourth miles east of the centre of Shalersville, and may be sought in Freedom, across the brook at the south. Its thickness is two and a half feet, and is nearer the lake than any known deposit of the same rock.

Limestone boulders are occasionally met with between this point and the Cuyahoga, westward, and also in Charleston, on the south.

They are most abundant in the western part of Northampton and Boston; in blocks somewhat worn by transportation, of all sizes under 20 feet in thickness.

In fossils and external characters, they correspond with the limerock of the islands, and the great lime formation 50 miles west; furnishing beautiful white quick lime.

The soil where they are most abundant, is strongly calcareous.

A heavy bed comes to the surface two miles west of the centre of Coitsville, and another, two miles southeast in the same township.

On the west line of Hubbard, about one half mile north of the middle, the blue limestone crops out from the west, and runs along northerly into Liberty, near the northeast corner.

A bed of lighter colored, tougher, and less compact stone, forms the surface rock in the southeast part of Jackson, and furnishes a quick lime of a whitish color.

Three miles west, and near the south line of Milton, a well wrought quarry is seen, which probably connects with the Jackson bed, though somewhat different in the specimen.

The southwest quarter of Berlin township, is underlaid by a stratum 2½ to 3 feet thick, very much twisted, with a gradual dip eastward. Fossils scarce and imperfect.

The same deposit crops out northward at the southeast corner of Deerfield, leaving remnants along the south side of the Mahoning val-

ley, and also the west side of the valley of Yellow creek, in large angular blocks, of frequent occurrence.

In the east and southeast part of Atwater, it appears in a mass inclining to the east, but soon ceases as we go west or northward. Some loose rocks have been observed near the centre of Deerfield.

The next locality of limestone, proceeding westward, lies on the north line of Suffield, at the middle; being a loose collection of rocks from a broken stratum; valuable by reason of the scarcity of the mineral. There are indications of a limited bed in the vicinity.

TUFA.

This imperfect limerock is observed at Cuyahoga falls; at Brandywine mills, in Northfield; and at the falls of Mill creek, at Youngstown; and also on lot 45, tract No. 1, Orange, Cuyahoga county. When remote from regular beds it may be turned to some account. It accumulates about the mineral springs in Edinburg, Hudson and Freedom, and unquestionably exists in many places not noticed, but in very limited quantities. It may be easily recognized by its porous, sponge like structure.

MINERAL SPRINGS.

No analysis having been made of mineral waters, a bare mention of the location of springs is all that can be expected at present.

Springs which deposit the oxide of iron, are very common, as well as those containing sulphur.

Near the Mahoning, in lot 9, north survey, Milton township, is a fine discharge of water strongly charged with uncombined sulphur.

At Price's mill, in the bed of the same stream, a small spring issues, which appears to contain several mineral ingredients not determinable without analysis.

In Edinburg, near the northeast corner, there are springs which deposit a white tufa in the form of a mound, about the orifice, in one instance several feet in height. The water is abundant, and not offensive, containing but a small quantity of sulphuretted hydrogen gas.

Water having sulphur in combination, is said to exist on Hinckley creek; two miles southwest of Charleston Centre, but I failed in the search for it.

Near Mr. Davis's, southwest of the centre of Freedom, is a flow of water which forms a kind of crater about itself, composed of calcareo-ferruginous tufa.

A similar deposit surrounds an extinct or feeble spring, or collection of springs, two miles northeast of the Western Reserve College, in Hudson. Eastward of this, about one mile, in the vicinity of ancient deer licks, it is not uncommon for the water which oozes from the ground, to deposit a light, fragile, calcareous tufa.

A copious discharge of water, at the junction of the coarse and fine-grained sandstone at Brandywine mills, contains iron, a trace of sulphur, and some unknown ingredients.

IRON ORES.

Connected with this important mineral, very little valuable information can be communicated.

It is found in a multitude of places throughout the southeastern part of Trumbull, and generally of an excellent quality.

The locations are also numerous in the southwestern part of Portage; in fact, it is a common deposit accompanying the coal—but is so little subject to the laws of stratification, the beds are so thin and limited in extent, that, for practical purposes, it cannot be denominated an iron region.

The most important beds are here named. One mile south of Ellsworth Centre, in the channel of Meander Creek, is a calcareous ore, 4 to 6 inches thick, containing zinc in small quantities. Lower down there are thin beds of argillaceous ore, and a coarse silicious stratum near the coal opening, but not workable. In Jackson township, east end of tracts 11 and 12, are several strata of an excellent quality. At and below Youngstown furnace, on Mill Creek, some heavy deposites of argillaceous ore are embedded in the black shale of the banks. The main bed is traced down the creek to its mouth, and is detected at several other points, being 4 to 8 inches thick.

The thickest stratum, in the valley of Dry Creek, on the opposite side of the Mahoning, 3 miles east, and the best formed bed below the furnace, on Yellow Creek, coincide as nearly in character with this ore as could be expected of specimens from places thus distant.

The ore bed, 5 inches thick in the brook, lot 3, division 4, Canfield, appears to be too silicious, but has not as yet been analyzed.

Admitting that these several locations may not be in a continuous stratum, there is still a greater body of ore in the region adjacent than I have observed elsewhere within the same space. The thickness does not, however, justify a drift, and it can only be taken from the water courses and the sides of ravines.

Other less important deposites lie both above and below this, and nodules of ore, of all kinds and sizes, are dispersed through all the rocks.

The lighter colored shale contains regular beds, from one to three inches thick, of the argillaceous kind, occurring once in 6 to 18 inches.

The great mass of the ore of northeastern Ohio is imbedded in these shale beds, both above and below the conglomerate, as represented in the general sections.

When the streams have cut through shale, it almost invariably exhibits layers of this rich ore from top to bottom, having a combined thickness of 2 to 3 feet in a hundred.

It is gathered from the water courses, and above the Poland furnace is dug out of the alluvion of Yellow Creek for use, at a depth of 4 feet, occupying the ancient channel of the stream. It is doubtful whether it will ever warrant the expense of digging, unless upon the face of high bluffs.

A rich collection of all kinds of iron ore, in connection with coal, lies near the surface in the northwest part of Hubbard. The specimens of kidney ore from these beds are very rich in metal.

South of the centre of same township, a half mile, there are three workable beds, 4 to 8 inches thick, extending apparently one mile east, in company with the coal.

There are also two thin beds beneath the coal mines, near the State line in Brookfield.

The defect of this section, as an iron-producing region, is not, as will be seen, in the deficiency of good ore, but in the want of concentration and regularity of the deposites. The present cost of ore at the furnace, per ton, is from 3 to 5 dollars, a price that cannot sustain the manufacture of pig metal.

There are in this section three furnaces, now in operation: one at the mouth of Musquito Creek, one near the mouth of Mill Creek, and another on Yellow Creek, the products of which are mostly of moulded iron.

The iron works at Akron and Middlebury are supplied from the southern mines, having ceased to rely upon the precarious and expensive supplies from beds in the vicinity.

On the right bank of Little Cuyahoga, one and a half miles east of Middlebury, in Edinburg, about one mile up Barrel Run, and in Palmyra, on Kale Creek, 2 miles east of the centre, are to be seen respectable beds of ore in the vicinity of coal.

The deposit of bog ores are too limited and uncertain to be made the basis of iron manufacture.

Specimens of all these ores are collected for the State cabinet, and for analysis.*

CLAYS.

The general soil of this region, is clay more or less diluted with sand, and therefore, the material for ordinary bricks is everywhere abundant.

There are also a great number of beds of *fire clay*, suitable for stoneware, being a concomitant of the coal.

The silicious shale which almost invariably forms the floor of coal mines, often disintegrates at the exposed edges, and in this state has a light color, resembling pulverized clay. It is a very good index of coal, though not always immediately accompanying it.

This clay, called "potter's clay," has various degrees of whiteness, from a light gray, to a white with a tinge of blue, governed in some degree by the stage of decomposition.

It lies in irregular patches of small dimensions and changeable thickness, as might be expected from its origin; has a greasy feel when made into mortar, and takes a light brown color.

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* An individual called Dr. Casey, had lately been in Trumbull county, representing himself as in the employ of the State. He gave the greatest encouragement to expect gold, silver, copper and zinc, and made contracts with many persons to explore for a share of the mineral. He wears gold spectacles, professes phrenology, and sometimes preaches; and when last heard of, was in Columbiana county.

There are several manufactories of stone-ware in the south part of the Reserve, and the beds supply some foreign establishments with material. There are five establishments in Springfield, Portage county, supposed to send abroad 60,000 gallons of the ware, besides home consumption, amounting to about 20,000, valued at ten cents per gallon at the shop. It has an excellent reputation, and is fast supplanting the red earthen-ware.

There is another near Price's mill, in Milton, and at Newton Cross Roads, supplied from a bed on lot 40, Jackson township.

Another, half a mile east of Canfield Centre, obtains its clay in the same township, a mile east and southeast; and two others, in Liberty, are supplied from a location near the northeast corner of the township.

The tough, ductile, blue clay, common in many places, is capable of moulding into ware, but cannot endure the heat of the baking process. It forms, however, a good glazing material for other clays, as it vitrifies readily at the point when they become well roasted.

It is not in every case that the proper *fire clay* will succeed in every part of the process. Some specimens that work well in mortar, melt in burning, others crack, some are not sufficiently hard, or the ware may fracture by heat after it is brought into use.

Fire bricks being in demand, and an article of great use in furnaces, cupolas and cooking ovens, and even in ordinary residences, I have subjected most of the samples collected in this quarter, to the the heat of melted iron, for the purpose of partially testing their refractory powers.

The tough, handsome clay, of lots 54 and 56, Northampton, contains lime, assumes a weak brick color at a low heat, and does not resist fire.

A light, yellow clay, with occasional crystals of selenite, lot 20, Milton township, became a purple scoria at welding heat.

Similar specimens, three-fourths of a mile southeast of Ellsworth Centre; same result. From lot 12, Youngstown; varied in color from a handsome light red, to dark brown; became hard and flinty under heat.

Near Youngstown furnace, not ductile; at the heat of melted iron, partially melted into a light grey, hard, porous mass.

Swamp clay, west of Tallmadge Centre, not adhesive; became dark, hard, and tough, without any signs of vitrification.

From lot 15, Coitsville; retained its *whiteness* through all stages of the experiment, and remained a hard, fine, compact flinty substance; not changed by this degree of heat. This promises to be a valuable bed, as the product resembles porcelain.

A parcel of yellowish clay from the canal, near Major Montgomery's same township, at red heat, became slightly red; welding heat, dark blue and porous, though hard; and finally, a light gray, flinty substance, not changed in form by the process.

Specimens from the worked beds were similarly affected; assumed a light blue color; became hard, tough and compact, and but little changed in form by this exposure. A mixture of pure, white, beach sand,

with as much potter's clay as is necessary to cement it well together, would form a brick capable of great resistance.

PEAT BOGS.

In the counties of Portage and Trumbull, only a very small proportion of the surface is occupied by swampy land. The southern, and especially the soutwestern part of Portage, including the townships of Brimfield, Suffield, Randolph, Springfield and Coventry, is more extensively intersected by low land than the other parts, but the individual swamps, though numerous, are in general of very limited extent and surrounded by high ground. These wet tracts, generally support a thick growth of small wood, bushes and grass, and accumulate a mass of vegetable matter, partially mineralized and partially decomposed, forming an imperfect peat. In seasons of excessive drought, like the present, they become dry, and an accidental fire has been known to consume several acres to the entire depth of the vegetable deposit. But I have seen only one locality of *proper peat* in a large quantity, which is at the summit lake, near Akron. It is not probable that the article can ever be of value as a fuel in a coal region.

The application of this "bog" or "muck" to cultivated lands, as a manure, has been but little attended to. Mixed with alkalies or good manure, in the proportion of 2 (bog) to 1, and suffered to ferment in heaps, it furnishes a superior compost for lean or exhausted soils. It is calculated that about 20 tons of this composition applied to an acre once in five years, will keep its vegetating ability in perpetual vigor. Thus what has been considered a valueless marsh, and even a nuisance, may be deemed one of the highest gifts of nature, and become an inexhaustible resource from which we may forever renew her strength.

SALT WELLS.

At the first settlement of the Reserve, a strong belief existed that it would prove a salt region. Brine, of which about 500 gallons made a bushel, was discovered in the valley of the Mahoning, just below the State line, and near the same stream in Wethersfield; and also on the south branch, in Milton, weak salt springs were known. In 1812, a boring was executed near the State line, on the Mahoning, to the depth of 150 feet, and some salt made from the well, but the water thus obtained, was no stronger than the run at the surface. About 1 mile from Lake Erie, and from the west bank of Rocky river, a well was sunk about 200 feet without success. On the lake shore, near the east line of Euclid, Messrs. Allen and Wilson, of Willoughby, have penetrated 900 feet, in search of salt water. The brine is not abundant, requiring about 160 gallons for a bushel. Below a depth of 500 feet no water made its appearance, either fresh or salt.

PORTSMOUTH—ENCROACHMENT OF SCIOTO RIVER.

The rapid action of the Scioto river upon its banks, was adverted to in last year's report, but the most important case, the destruction of the peninsular part of the city of Portsmouth, failed of an introduction. The accompanying sketch of the stream and the town, with the profile attached, will show, at a glance, the condition of the premises.

A tongue of land, elevated from 50 to 70 feet above low water in the Ohio, comes down along that river, partly across the immediate valley of the Scioto, caused this stream to pass along its northern face and enter the river a mile westward.

An examination of the profile, across this neck, on the line *a*, *b*, will show its geological structure.

1st. We find at the ordinary level of both streams, a deposit of sand and gravel, somewhat compact and nearly impervious to water.

2d. Resting upon it, is a bed of coarse, water-washed gravel, about 15 feet thick, the pebbles upon its surface agglutinated by a ferruginous cement, to the depth of from one and a half to two feet.

No. 3, is a stratum of fine, blue sand, generally 3 feet thick, but increasing to 20 feet at the extremity of the point. It embraces a multitude of the trunks, branches, and leaves of trees still retaining their form and texture. They are so abundant, that wells sunk to and through this stratum, furnish an impure water, called by the inhabitants, "swamp water," owing to the presence of vegetable matter.

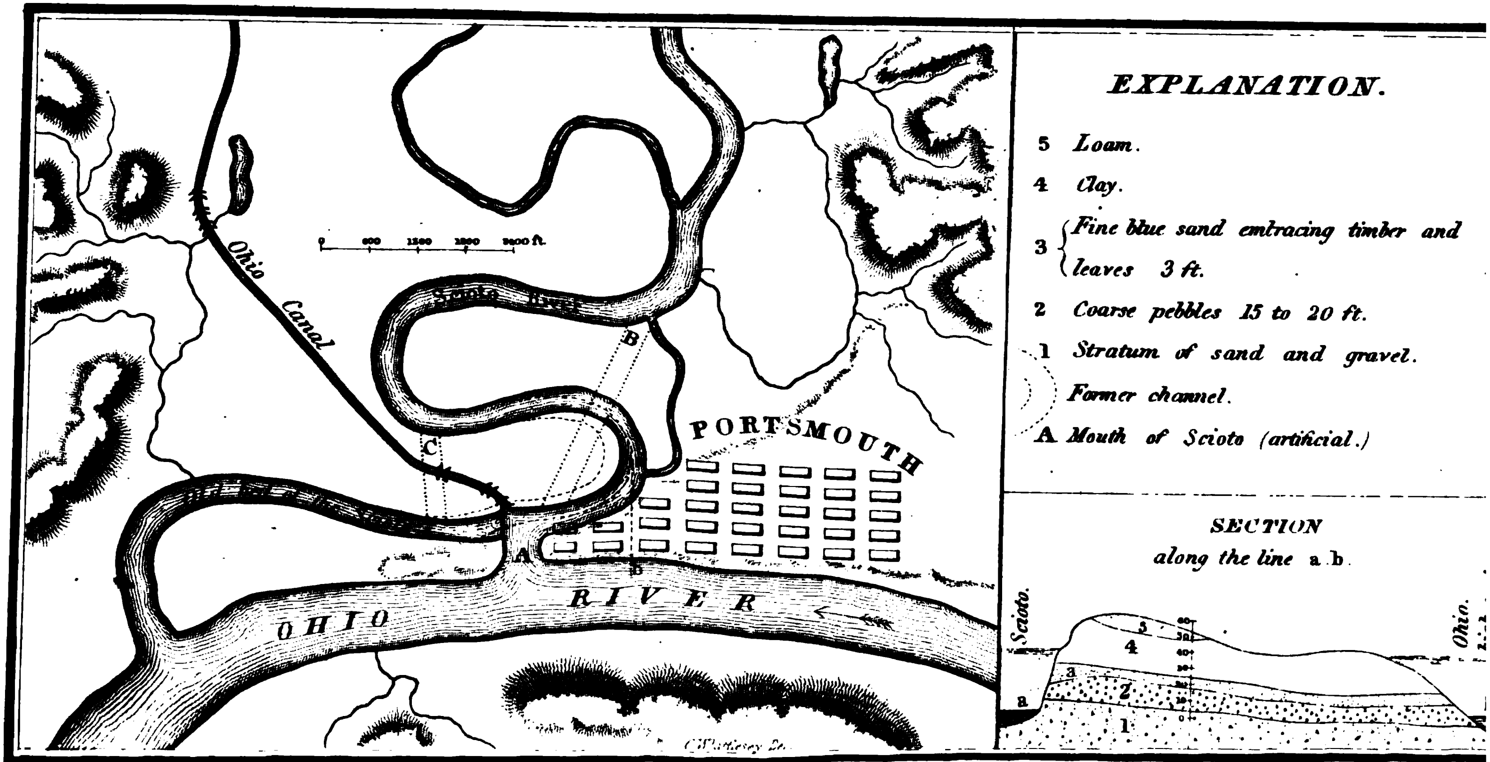
Upon this, rests a yellowish clay, No. 4, capable of being made into bricks; the thickest part, 30 feet. It is homogeneous, and free from gravel, timber, or other foreign materials, along the margin of the river, but becomes somewhat sandy as we go from the shore, finally changing at the surface, to the loam represented by No. 5. This bed of loam is the extremity of a gentle, sandy ridge, which rests upon the clay, extending through the town, eastward, nearly parallel with the river.

In floods, the waters of the Scioto rush against the bank at *a*, with great force, and of late years, a large body passes through the 'thoroughfare' or 'cut off,' which has its debouche near the same point.

This new channel, induced by a mill race across the neck, bids fair to become the main passage. On the Scioto side, the *sand* of stratum No. 1, predominates, and in consequence, the water carries away the substratum of the place with great rapidity, and the incumbent beds fall down and are swept along with it.

It will thus be seen that there are *no natural obstacles* calculated to retard the ravages of this current, and unless checked by artificial means, the destruction of that part of the city below 2d West street seems inevitable.

Its channel has advanced towards the Ohio about its own width, since the occupation of white men, and the artificial mouth at A, effected by the State for the passage of canal boats, which now discharges all the



OHIO RIVER
Scioto River
Ohio Canal
PORTSMOUTH
A
B
C
b
0 600 1200 1800 2400 ft.
EXPLANATION.
5 Loam.
4 Clay.
3 {Fine blue sand embracing timber and leaves 3 ft.
2 Coarse pebbles 15 to 20 ft.
1 Stratum of sand and gravel.
Former channel.
A Mouth of Scioto (artificial.)
SECTION
along the line a.b.
Scioto.
Ohio.
a
1
2
3
4
5

water at ordinary stages, has apparently increased the abrasive power of the stream.

Until the unstable sand stratum, No. 1, is in some manner protected from the wash of the current, or the channel of the Scioto changed to some other ground, there is no prospect of a different state of things. A stone facing at the most exposed parts, is liable itself to be undermined and lost.

If the object will justify the expense, a general grade of the Scioto bluff, in which care should be taken to face the whole escarpment with clay, and covered, between high and low water of this river, with blocks of stone, would doubtless be a protection.

But the most certain and economical method, would seem to be a *change of the channel.* The proper point to effect this, appears to be at the neck, C, occupied by the canal, closing at the same time, the inlet at B.

The present location of the canal, however, prevents the first part of the arrangement. A diversion of the water from the mill race, would still be an important object. It is, undoubtedly, practicable to lead the entire volume of the stream from the point B, to A, by a direct cut, represented in dotted lines, and at an expense, less than the grade with stone work.

But whether this can be effected without endangering the canal, I am unable to say. A change, by leading the channel from B, across the first bend, throwing the force of the current against the alluvial ground above and opposite to *a*, might, and probably would shift the thread of the stream westward, to its former position, in a few years.

CHAS. WHITTLESEY, *Topographer.*

COLUMBUS, *December* 1, 1838.

REPORT OF MR. FOSTER.

To Prof. W. W. Mather,
Principal Geologist of Ohio:

Sir:—The following report embraces the principal facts relating to the geology of Muskingum county and parts of Licking and Franklin, collected during the past season. Owing to causes unnecessary to mention, I have not been enabled to make as detailed a survey as is desirable. With all its imperfections, this report is respectfully submitted, with the hope that it may stimulate our citizens to explore more minutely than has yet been done, the mineral resources of the State.

PRELIMINARY OBSERVATIONS.

The great object of science is the acquirement of facts. It is to this, rather than accident, that we are indebted for most of the practical arts of life. Science, therefore, precedes art, as a knowledge of principles necessarily precedes their application. By a careful and extended survey of natural phenomena, the geologist has been able to detect a uniformity of succession in the different mineral masses which compose the crust of the globe. This physical knowledge is of direct and practical utility in mining operations, as it will deter many from expensive explorations, where there is not a reasonable probability of success. Thus, one acquainted with geology would not look for coal in primary, nor tin in secondary formations; because their occurrence under such circumstances would be a deviation from that fixedness and uniformity every where observable throughout the works of nature. Every year affords instances of expenses incurred and labor expended in search of lead and the precious metals. One so ill-directed and visionary occurred in Muskingum county, that it deserves to be recorded as a warning to the credulous.

About eighteen years ago, a person engaged in boring for salt water near Chandlersville, represented that, at about the depth of 140 feet, the pump brought up a bright metallic substance resembling *steel filings*. Portions of this substance were procured, tested, and found to be silver. On the strength of this, a company was incorporated in 1820, with a capital of $50,000, under the name of the Muskingum Mining Company, the object of which, as set forth in the somewhat singular lan-

guage of the act, was "to perforate or sink a shaft in and through a rock, for the purpose of mining, raising, and eventually working, smelting, or refining, all silver or other ores which may be found within or under this or any stratum of rock or lamen of earth."* The State, in consideration of their working the mine on the salt section, reserved to itself 15 per centum on the nett proceeds. The stock was rapidly taken up—machinery erected on a scale of vast expense, and the shaft sunk a few yards from the well, to the depth of 140 feet. At this depth, the workmen struck the rock (hornstone) supposed to contain the silver, but not a particle was found. They then drifted horizontally till they arrived within a few feet of the well, when the plug by some mischance gave way, and the water rushed in rapidly. The workmen were obliged to abandon their tools and betake themselves to the buckets. The shaft immediately filled, and has to this day remained undisturbed—an example of abortive and ill-directed exploration. It is probable that a silver coin was inserted, either through accident or design, into the well, and brought up, among the scrapings in a pulverized state. Not less than $11,000 were expended on this project. It is needless to add, that a knowledge of the formations in which silver occurs, and of the aspect which it usually assumes, would have deterred them from an undertaking, the labor of which was certain and the success precarious.

Extensive excavations have been made on Flint Ridge, and with like success. These examples show the necessity of diffusing correct geological information among the mass of the community. The first principles of the science are easily acquired, but the minute details are the work of years. The history of mining operations, says Herschel, in his admirable discourse on the study of Natural Philosophy, is full of cases, where a very moderate acquaintance with the usual order of nature, to say nothing of theoretical views, would have saved many a sanguine adventurer from utter ruin.

The study of organic remains, too, which is generally regarded as a branch of useless learning, is of practical utility. The geologist has discovered that each of the sedimentary deposits has its characteristic fossils. By this means he can determine the epochs of the different formations, identify the same formation at remote points, and throughout all its lithological changes, and even calculate with some degree of certainty, the periods when the present mountain chains were lifted up. These fossils indicate a progressive development of organic life, from the coral, closely allied to the vegetable, to man, the head of created beings. From them also, we learn the various revolutions which the earth has undergone, the changes in the temperature of its surface, and the animals which peopled it in periods far remote. Throughout these successive revolutions of the earth, there is a manifest design on the part of a beneficent Providence, to adapt it to the residence of man.

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*18. O. L. L. 72.

The uniformity of nature is the only guide to the geologist in his investigations. On this, experience has taught him to rely with confidence. If he occasionally meet with an anomaly, it is attributable to a hasty assumption of data, rather than a deviation from the natural order of succession; to confounding those relations which are fixed and universal, with those which are local and incidental.

PHYSICAL GEOGRAPHY.

The region which is the subject of this report, embraces the county of Muskingum, and parts of Licking and Franklin. The face of the country in the western part, is level or gently undulating; proceeding east, it becomes more hilly till we arrive at the out-cropping edges of the conglomerate, which, swelling out in bold, precipitous scarps, affords many scenes of picturesque beauty. The eastern section of the district presents a succession of elevations and depressions. The hills frequently attain a height of 300 feet above the water courses, with a mean altitude of 1000 feet above the Atlantic. They range not in regular mountain chains, but present a labyrinth in which no system can be traced. In general, their summits are rounded, while their flanks are furrowed with deep ravines. The intervals between, appear to have been scooped out by running water. There can be little doubt of their former continuity, as, on either side, they present the same series of strata and the same order of superposition. Most of the valleys are due to this cause. Indeed, in the whole course of my geological investigations, I have not seen an instance of their formation from the fracture or contortion of the strata.

The principal streams which traverse this region, are the Scioto and Muskingum. They penetrate, with their numerous tributaries, every part of the region, like the veins in the human system, and serve as channels to discharge the superabundant waters. The Scioto is the principal stream in the middle of the State. Flowing through a level country, its course is serpentine and its current sluggish. Its descent between Columbus and Portsmouth, a distance, by estimation, of 150 miles, is 224.75 feet, or 18 inches per mile. It is constantly shifting its bed, and affords a good illustration of the agencies of running water. The broad alluvia which border it, are subject to extensive and continued inundations, during certain seasons of the year, in which the finest sediment is deposited. The descent of the Muskingum is more rapid, being, between Dresden and Marietta, a distance of 90 miles, 129.67 feet, or about 20 inches per mile. Flowing through a hilly country, its bed is less subject to fluctuations. Aside from irrigation, they exercise an influence on the soil, in the deposites of detritus which they annually make, which serve to renovate the soil, acting as a mineral manure. Many of the bottom lands along the Scioto have been cultivated for thirty years without dressing, yet their fertility is little diminished.

Having given the physical features of the country, we now proceed to its

GEOLOGICAL STRUCTURE.

For the convenience of description, I will arrange the different formations in groups, beginning with those which occupy the highest place in the series, and are, therefore, the most recent, and descending to those which are the lowest, and are, therefore, the oldest. These divisions are, for the present, arbitrary, and liable to be altered or confirmed by subsequent investigation.

I. ALLUVIUM,*	1. Beds of rivers. 2. Incrusting springs. 3. Peat marshes.
II. TERTIARY,	1. Boulders of granite. 2. Beds of pebbles, clay, sand.
III. COAL MEASURES,	1. Coal. 2. Iron ore. 3. Buhr and hornstone. 4. Shale. 5. Limestone. 6. Sandstone. 7. Salt springs. 8. Conglomerate.
IV. FINE-GRAINED SANDSTONE,	Comminuted sand interstratified with beds of shale.
V. SHALE,	Thick beds of argillaceous shale, with septaria and iron nodules.
VI. MOUNTAIN LIMESTONE,	Beds of limestone intermixed with chert.

I. ALLUVIUM.

Under this head is included all those formations which are clearly referable to causes now in operation; such as inundations of water; the shifting of the beds of rivers; the accumulation of silt at their mouths; the disintegration of the strata by atmospheric agents; the deposits of springs, and the growth of peat.

Under the preceding head, we have noticed the effect of streams in modifying the face of the earth.

* For the manner in which the several groups are arranged, and the relations which they occupy to one another, see the section appended to this report.

INCRUSTING SPRINGS.

At a temperature of 60° Fahr., lime is soluble in 700 times its weight in water, and if to this solution, a small portion of carbonic acid is added, a carbonate of lime is formed and precipitated in an insoluble state.* Of deposits formed from springs of this character, I know of but two instances in this district, although their occurrence in other sections of the State is not uncommon.

A few rods north of Cumberland, there is an incrusting spring. The water in flowing over a bed of limestone which readily disintegrates into marl, takes up particles of lime, and deposites them in the fissures of a sandstone below. Some of the specimens are a pure crystalized carbonate of lime, while others contain earthy impurities. Near the lockpit at Zanesville, the Muskingum, in the course of ages, has piled up a thick bed of pebbles. Above it occurs a bed of limestone and the water in flowing over it becomes saturated with lime, and deposites it in the interstices between the pebbles. In this way, a coarse conglomerate or pudding stone has been formed, several feet in thickness.

PEAT.

When vegetable matter is exposed to moisture, at a low temperature, it looses its organic texture, and becomes converted into a dark, unctuous, tremulous mud, called peat. When dried, it is combustible, emitting a strong bituminous odor. A cold humid climate is the most favorable to its production. Much of the peat is formed from the *sphagnum palustre*, a moss which has the property of shooting up new sprouts from the top, while the lower parts undergo decay.—Some of the peat is formed from prairie grass and leaves. In general, says Sir H. Davy, 100 parts of peat contain from 60 to 99 parts of matter destructible by fire: and the residuum consists of earths, usually of the same kind as the substratum of clay, marl, gravel, or rocks, on which they were formed, together with the oxide of iron.—Peat is found in the wet marshes in the vicinity of Columbus, but is not of a superior quality. At Nashport and Frazeysburg, it has been observed in the form of a tremulous mud. It is also found on some of the open grounds near Zanesville. Good beds will, undoubtedly, be brought to light on further examination. They will be, however, of little economical value, while our present forests remain.

In many parts of the United States, peat has been successfully employed in burning brick and lime. It is of some economical value in agriculture, as a manure.

II. TERTIARY.

This deposite occupies an extensive area in the interior and western portion of the State. The mode of its formation, the gigantic remains

* Org. Rem. vol. 1, page 373.

of the mastodon and elephant, which arè entombed within it, and the probable causes which led to their extinction, are subjects of much scientific interest. It is generally made up of stratified deposites of sand, gravel, clay, with an admixture of lime and loam. Over this surface, granite boulders, some of which are of immense size, are irregularly scattered. These deposites repose unconformably on the subjacent rocks, filling up the pre-existing depressions and inequalities in the surface. Through this coat, the underlying rock rarely makes its appearance.

In this district, the tertiary occupies a large space. Its eastern boundary may be indicated by the conglomerate, which is found near Jacktown, Licking county; from thence it extends to the western line of the section, occupying nearly all of Franklin, and nearly two thirds of Licking county. The comminuted state of the lower strata, and the regularity of their stratification, indicate that they were deposited in still waters; while the boulders and the pebble beds, many of which are highly irregular in their stratification, indicate that they were thrown down in an agitated state of the waters. Occasional patches, like estuaries of the sea, are found in the borders of the coal measures, as at Nashport, Frazeysburg, and Dresden. These beds, from their extent and regularity of stratification, are, probably, sub-aqueous deposites.

The following may serve as a general section:

1. Vegetable mould.
2. Loam, or a mixture of sand and clay.
3. Sand and pebbles.
4. Yellow clay.
5. Dark blue clay effervescing with acids.

Over these deposits are found large boulders of granite, syenite, quartz, &c. These rocks have been appropriately termed by the French, *terrains de transport*, from the circumstance that they have been transported to great distances from their primeval beds. They are found scattered over the surface along the borders of the coal measures, from Lake Erie to the Ohio river. Speculations as to their origin or mode of transport would not come within the range of this report. It is highly probable, if not certain, that no primitive rocks exist *in situ*, within the borders of our State. Yet here are boulders, many of which are of immense size, that have been transported hundreds and perhaps thousands of miles from their original localities. To one accustomed to look at the transporting power of our rivers at this day, these results seem almost incredible. In the western portion of this district, these boulders are abundant, being found on almost every section. The corners are worn off as though they had been subjected to the action of a heavy surf. The region about Columbus affords many varieties of these erratic blocks, some of which contain 1000 cubic feet; and they are found at short intervals, as far east as Newark and Jacktown. On the hills southeast of the former place, I observed several, two or three hundred feet above the bed of the Licking From Jacktown to Zanesville their occurrence is

rare. A few have been observed in the Muskingum Valley, but not even a primitive pebble has been found on the highlands east of Zanesville. It is not improbable, therefore, that the conglomerate formed a barrier to the aqueous currents that swept over the western portion of the State. The valley of the Muskingum, however, may have formed a connecting channel between the Ohio valley and the eastern limit of this formation. In addition to these, large beds of water-worn materials derived from primitive and secondary rocks, are found over the surface of this formation. The excavations on the banks of the Scioto, near Columbus, afford good sections of these materials, and they are also found in the Muskingum valley. Made up as they are of the debris of primitive rocks, it is not unusual to find in these accumulations, minerals foreign to the region they pervade. I have in my possession a specimen of the sulphuret of antimony, of considerable size, found about a mile above Zanesville. Some years ago, a specimen of lead ore (galena) weighing 2 pounds, was found on Moxahala creek, on the land of Judge Jeffries.

Agricultural Character.—This formation, being made up of beds of sand, clay with a considerable admixture of lime, contains all the elements of a good soil. Where clay abounds, it becomes cold, wet, and heavy. In such cases, drainage might be practiced with success Where this is impracticable, the agriculturist might drill holes through the impervious stratum, and conduct the water to them by radiating drains, in cases where beds of sand lie below the clay. From the looseness of its texture, it would absorb the water and render the super-stratum sufficiently dry for arable purposes. By this means, many marshes in Europe and America have been reclaimed to the Agriculturist.

The addition of sand, also, to a clayey tenacious soil, is beneficial, as it renders it more porous and open, permitting the water to filter through it. The clay marl associated with the tertiary, contains a considerable portion of carbonate of lime. It can be readily detected by pouring acid upon it. Effervescence denotes the presence of lime, and the quantity is indicated by the briskness. This is a valuable mineral manure, when spread over a sandy, arid soil. The clay would retain the water while the lime would not only neutralize the vegetable acids which most soils contain, but at the same time act as a stimulant to vegetation.

Thickness.—The thickness of this stratum may be estimated from 50 to 150 feet.

Organic Remains.—The mastodon maximus of Cuvier, and the elephas promogenius of Blumenbach, may be regarded as the characteristic fossils of this deposite. The occurrence of these gigantic remains excited the wonder of the pioneers of this country. As far back as 1765, Mr. George Croghan, an English tourist, visited a locality of these remains, from which he procured several bones belonging to the mastodon, and transmitted them to London, in the year 1767. The European naturalists debated for a long while, whether the animal to which they belonged was herbiverous or carniverous; whether it was

more closely allied to the rhinoceros than the elephant. It remained for M. Cuvier to solve these doubts, and assign its true position in the animal kingdom.

The molars of the elephant and mastodon have occasionally been found in different parts of this district, but at this day it is difficult to ascertain the localities.

In excavating the canal at Nashport, the workmen dug up a number of fossil bones.

The following section taken by Col. Whittlesey, about one half of a mile north west of Nashport will illustrate the nature of the materials in which they were found.

STRATA.	FEET.	
1. Yellowish clay	14	25
2. Dark carbonaceous silt, provincially termed "muck," containing the fossil bones	3	
3. Pebbles of primitive rocks	8	

4. Blue clay at the bottom of the canal.

The following were the bones, as far as can be ascertained, brought to light during the excavation.

A tusk 8 or 10 feet long, which crumbled to atoms on exposure.

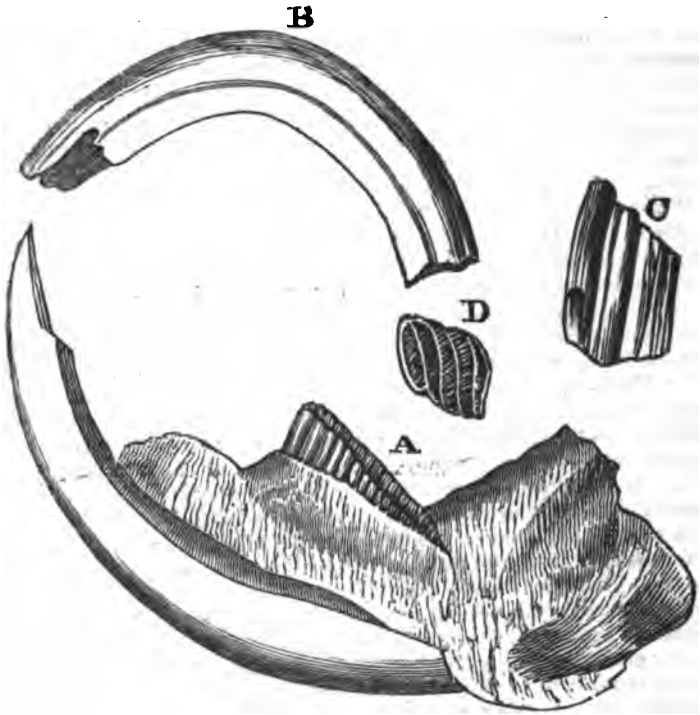
A small tusk 3 inches in diameter similar to the above.

A large curved substance represented by those who saw it, as a "horn 8 or 10 inches in diameter, and hollow to the tip."

The right half of two under jaws, belonging to animals of the order Rodentia.

A molar and part of a tusk belonging to the elephant, a molar belonging to the mastodon, the head of an undescribed species of fossil ovis, and one of the jaws belonging to the order Rodentia, (figured below) before spoken of, are preserved in the Zanesville Athenaeum.—Mr. Adams informs me that they were taken from the "deep cut," in which the other bones were found. In some respects this jaw agrees with the castor, while in others it differs specifically. These differences will be found to consist, not only in the size of the jaw, and the longitudinal striæ of the incisors, but principally, in the configuration of the enamel of the teeth, which naturalists have hitherto regarded as a sufficient distinction for the erection of a genus. As there are, however, some points of resemblance, the generic term, CASTOROIDES, is perhaps, the most appropriate which could be selected. Since this fossil has been found only within our State, I will disignate the species, *Castoroides Ohioensis*.

From the connexion in which these bones were found, this animal was probably contemporaneous with the elephant and the mastodon, and may have been destroyed by the same catastrophe which swept them from the face of the earth.



A, Lower jaw, reduced more than one-half.
B, Upper incisor, " " " "
C, First molar, natural size.
D, Crown of the fourth molar, natural size.

ORDER, RODENTIA.
Genus, CASTOROIDES.
Species, *C. Ohioensis*.

Generic characters.—Incisors $\frac{2}{2}$, destitute of canines, grinders $\frac{4-4}{4-4}$; total 20. Incisors of the lower jaw convex in front and longitudinally striated; posterior surface, angular, smooth and slightly concave. The grinders are obliquely traversed by six ridges or folds of enamel.

The Castoroides Ohioensis must have surpassed in magnitude all the animals included in the order Rodentia. The length of the lower incisor from the tip to the base, around the outer curve, is 11 inches 6 lines. Portions of the anterior and posterior processes are gone, so that it is impossible to ascertain the exact length of the jaw. The fragment from the tip of the incisor to the condyloid process is 9 inches 2 lines,—the height from the base to the coronoid process is 3 inches 8 lines. The lateral portion of the jaw is also broken, so that the incisor is exposed nearly to the base. This jaw has been figured in the 31st vol. of Silliman's Journal, but no generic or specific name given.

While upon this subject, I am happy to quote from a letter of R. Harlan, M. D. of Philadelphia, who, as a comparative anatomist, ranks deservedly high. I had previously submitted a drawing to him, accompanied with a description. From his reply I make the following extract: "I have perused your account of the fossil (above described) with much satisfaction, and perfectly agree with you in opinion, that it is the remains of an extinct species of mammiferous animal of the order Rodentia; and I think further, that it might be referred to the genus Castor, or beaver, although there are differences in its structure which point to a distinction of genus. A fossil species of castor has already been found at Taganrok, near the sea of Azof, in loose materials. It is one-fifth larger than the European Castors, (and these are larger than the American species,) but resembling the modern Beaver in its anatomical details, in which it essentially differs from your species, as I shall notice presently. One other specimen of fossil castor has been found near Lake Rostoff, inferior in length and agreeing in all details with the recent species. The first noticed above, or the Taganrok specimen, was described by Prof. Fisher of Moscow, as an extinct genus under the name of *Trongotherium*. Vide Cuv. Oss. Foss.

"As regards the difference of the specimen in your possession with the common beaver or castor fiber; 1st as to size. Your specimen exceeds the largest of our recent specimens one-half. The length of your specimen is 9 inches 2 lines. The largest jaw of the C. fiber in my possession is 4 inches 2 lines. The height of your specimen from the coronoid process to the base of the jaw is 3 inches 8 lines. The height of my largest specimen is 2 inches 2 lines.

"There are some differences also in the longitudinal markings of the molars; but the principal difference will be observed in the configuration of the enamel of the crowns of the molars. These teeth in *number* resemble those of the beaver, which have three ridges of enamel on the internal edge of the lower teeth, and one ridge on the outer edge. There are some minor differences in the shape of the exterior outline of the jaws with the beaver. If you should conclude to construct a new genus, how would Castoroides answer for a name?"

From the anatomical details above given, it would seem that the C. Ohioensis was an animal closely allied to the beaver, but far surpassing him in magnitude. Its life probably was aquatic, and its food consisted of vegetable substances, which he gnawed off with his powerful incisors.

The jaw was incapable of horizontal motion except from back to front, and the transverse arrangement of the enamel is such as to have enabled the animal to gnaw the hardest ligneous substances. Viewed in this light, there is a mutual correspondence in the various organs, and an admirable adaptation to the offices which they were designed to discharge.

III. COAL MEASURES.

The rocks which compose this series consist of limestone, sandstone, shale and buhr, interstratified with beds of coal and iron ore. They are accompanied, also, with the phenomena of saline springs. The minerals stored in this formation will prove a valuable source of wealth to the State, and ages must elapse before they become exhausted. The abundance of coal and the facility with which it can be mined, will, at no remote day, supply the place of water power in the propulsion of machinery, and render it the most potent of agents in the arts of life. The mechanical power of coal is strikingly illustrated by Herschel: The ascent of Mount Blanc, says he, from Chamouni is considered, and with justice, the most toilsome feat that a strong man can execute in two days. The combustion of two pounds of coal would place him on the summit.

The mineral wealth stored in the bosom of England is the mainspring of her unbounded prosperity. It is this, which has enabled her to support a dense manufactuaing population, and push, to so vast an extent, the bounds of her dominion. Hitherto, Ohio has been mainly dependent for her prosperity, on her agricultural industry. Her mineral treasures have been but imperfectly explored and still less appreciated. The developements which have been made in her geology have shown, that the eastern section of the State is rich in coal, limestone and iron ore. The proximity of these materials to one another and the facility with which they can be mined, must result in the investment of a large amount of capital in furnaces and foundries, and the concentration of a dense manufacturing population along the line of their outcrop; while the channels of communication natural and artificial, admit of a ready transportation of the products of industry to every part of the Mississippi Valley. Regarded in this point of view, as a permanent source of wealth and population, an inquiry into the range, quality and extent of the mineral deposits of the State, becomes a proper subject of legislative enactment.

COAL.

Coal is generally regarded as resulting from vast accumulations of vegetable matter, modified by water, and perhaps, by heat. The experiments of Hall, Hutton and M'Culloch on vegetable substances and coal, render this theory of its origin highly probable, if not certain.

Chemical and external characters.—Two varieties of coal occur in this district, viz: bituminous and cannel. The first variety is composed of mineral charcoal, bitumen and a small residuum of earthy matter. In

what proportion these ingredients exist, I am not prepared to state, as none of the coal of this region has yet been analyzed.

Its color is black, its lustre resinous and not unfrequently pseudo-metallic. It breaks into trapezoidal blocks, and during combustion, agglutinates, giving a bright yellow flame.

The second variety resembles a dark shale, highly impregnated with bitumen. It differs in composition from the former variety, containing less bitumen and more earthy matter. It burns with a bright flame, but does not agglutinate. Where the earthy matter predominates, it passes into bituminous shale; and the transition is often observed in short distances. It rarely contains any traces of vegetables, but marine shells have occasionally been observed. This coal in England, first went by the name of "candle" coal, because it was used as a light by the miners; which, in process of time, became corrupted itno "cannel," a term which it has since retained. It is objectionable, as it conveys no definite idea of the object to which it is applied.

Range and extent.—The rocks, in this district, which embrace the coal, are an inconsiderable portion of the great formation which traverses the State in a N. E. and S. W. direction, and are embraced in the western portion of that formation. The conglomerate, which, so far as observed, underlies all the coal of Ohio, crops out a few miles east of Jacktown and Newark. Between that line and the eastern boundary of Muskingum county, no less than seven beds of workable coal are found, besides ten or twelve which are so thin as to be of little economical value. In noticing the different beds, I will begin with those which occupy the highest place in the series.

On the land of W. Gilloghly, (Sec. 9. Meigs township, Muskingum county,) is a bed of coal which I am disposed to regard as the highest in the district. The following section will show the thickness of the associated rocks:

STRATA.	FEET.
1. Sandstone containing much mica	40
2. Dark shale	2
3. Sandstone fissile	20
4. Limestone decomposing into marl	8
5. Tough blue limestone	2
6. Fissile sandstone	6
7. Limestone with a chalky feel, decomposing into marl	1
8. Sandstone	40
9. Coal	1
10. Shale	1
11. Coal	3.6
12. Shale	10
13. Limestone	4

There is evidently a dislocation of the strata over a considerable area, as they dip here, from 6° to 8° to the N. W. This coal, proba-

bly, is to be found in the S. E. quarter of Blue Rock and Rich Hill townships, and in the greater portion of Meigs. It is disclosed on some of the forks of Wills creek, and at Cumberland.

About five miles east of the line of Muskingum, near the tavern of Mr. Grummon, on the national road, occurs a bed of cannel coal. It was first noticed by Judge Tappan, in the 18th volume of Silliman's Journal, and subsequently by Dr. Hildreth in the 29th volume of the same periodical. According to the former gentleman, the specific gravity is 1.6, which is far greater than any coal hitherto noticed. The fracture of this coal is highly conchoidal, lustre resinous, and its combustion is attended by a brilliant flame.—Thickness, two feet.

On the summit of Norwich hill, is found a bed of coal of about the same thickness, though differing in external characters. It may be identical with the one last noticed. This bed probably extends through Highland, Union, Rich-Hill and Blue Rock townships. About two miles north of Norwich it has been opened, on section 3, Union township. It is of an inferior quality, and the fissures are penetrated with films of calcareous spar. On section 1, it makes its appearance by the national road a little east of the village of Concord. It has also been opened on the land of Mr. Calhoun, section 3, Rich Hill township, and on the land of J. Forshee, Esq., section 19, Union township.

Another bed makes its appearance by Little Salt creek, on the national road, and may be seen by a little ravine, near the bridge. It has been opened on the land of John Culbertson, section 14, Perry township.—Thickness, two and a half feet. The specimens I observed were so weathered as to render it impossible to judge of its quality.

The next bed crosses the national road at Jackson, Washington township, and is the thickest in the county, being from 5 to 7 feet. From Mr. Alexander's bed, considerable quantities are annually taken to supply the villages of Concord and Norwich. This coal contains a good degree of bitumen, burns freely in the grate, but contains so much pyrites as to render it unfit for making iron. As an article of fuel, it will be invaluable when that region is stripped of the forests which now shade it. The same bed has been opened on the land of John Lewis, section 10, Wayne township, and is probably continuous through Brush creek, Wayne, Perry, Salem and Adams townships.

At Zanesville, four beds of coal occur, three of which are workable. To show the order of their superposition, and the nature of the rocks with which they are associated, I will insert the following section, taken near Ballantine's mill.

STRATA.	FEET.
1. Vegetable mould	1
2. Sandstone (quarried)	40
3. Blue Shale	5
4. Bituminous Coal	2.8
5. Bituminous Shale	2
6. Sandstone	40

STRATA.	FEET.
7 Shale	8
8. Bituminous Coal	2.6
9. Shale and fissile sandstone	25
10. Blue limestone	4
11. Bituminous Shale with thin leaves of coal	6
12. Fissile sandstone	5
13. Bituminous Shale with leaves of coal	3
14. Coal	2.2
15. Blue Shale	6
16. Slaty Sandstone	12
17. Shale	7
18. Compact Sandstone	6
19. Shale with nodules of iron ore	3
20. Grey micaceous Sandstone	2
21. Shale with layers of iron ore	2.6
22. Black Shale	3
23. Sandstone	6
24. Cannel Coal	1.4
25. Shale	5
26. Blue limestone	8
27. Coal	6
	215.6

Bed of the Muskingum river.

The two upper beds are extensively mined in the hills of this region, to supply the town. The principal beds are Fulton's, Cox's, Parkinson's, Hall's, &c. Their average thickness is greater than given in the preceding section. Above Zanesville, on the Muskingum river, these strata have been opened, and an excellent quality of coal procured.—The bed No. 14, has been opened at Ballantine's mill, but is of an inferior quality. On the opposite side of the river, at Putnam hill, it is about 1 foot thick, and, as it is traced west, dwindles into a thin seam not more than three or four inches thick. The western outcrop of these beds, on the line of the section, is at Mt. Sterling. The coal there opened is of a poor quality. At Taylorsville a stratum of coal occurs a few feet above the surface of the river. It is between 2 and 2½ feet in thickness, and of a good quality. An excellent coal occurs on the land of J. Springer, section 16, Springfield township, but the bed is thin.

The cannel coal (No. 24,) was brought to light during the excavation of the culvert at Slago's run. It is slaty in its structure, exhibits a resinous lustre on the cross fracture, and contains a large proportion of earthy matter. Portions of it are highly glazed as though they had been subjected to partial fusion. In this bed were found several branches and trunks of trees. The bark was converted into a black and highly splendent substance, resembling jet, the trunk partook of the characters of the main bed, while the pith or

centre was penetrated with chalcedony or an imperfect wood opal. This bed has been observed in West Zanesville, and in Falls township, on the land of Col. Chambers.

The lowest bed of coal in this district is found between the conglomerate and the buhr, and is the only one found between those members of the coal series, sufficiently thick to be worked. There are, however, one or two beds which are more than a foot in thickness, and may be found to swell out to such an extent as to justify mining. This lowest bed of coal has been opened on the land of Mr. Robinson, about a mile west of Brownsville, Licking county. It is overlain by fissile limestone, intermixed with chert, and is perhaps three feet in thickness, separated by a thin seam of shale. A few miles north of this, on section 3, Hopewell township, Licking county, a fine bed of cannel coal has been opened. It is owned by Mr. Isaac Irvin, of Newark. The following is a section taken at that place:

1. Limestone fissile, intermixed with chert, from 10 to 14 feet in thickness.
2. Cannel coal—1 foot.
3. Shale containing more or less lime—5 feet.
4. Cannel coal—3½ feet.

The coal is more slaty in its structure than that which is found in Guernsey county, and probably contains more earthy matter. It resembles a dark shale highly impregnated with bitumen, and burns with a bright flame, but does not agglutinate. This coal is used to some extent at Newark for fuel. From its situation and the associated rocks, I am disposed to regard it as the equivalent of the coal found at Brownsville. It is not uncommon to find bituminous coal passing into cannel; or even to find them blended together at the same point. Rocks, at remote points, present different aspects; and it is vain to expect a uniformity of character over extended areas.

I have, thus, enumerated the different strata of coal found in this district. It is deemed unnecessary to mention all of the localities at which they have been observed. It will probably be found in every township in Muskingum county, in sufficient quantities to supply the wants of the inhabitants, and perhaps, in some of the eastern tier of townships in Licking county. The conglomerate will afford a sure guide to the miner in his investigations. No coal in Ohio has yet been discovered below that formation.

Estimate of the amount of coal. I have already estimated the amount of coal in Muskingum county at 359,712,000 square yards. The data on which that calculation is founded, are given in the report of Prof. Mather. Here, then, is fossil fuel embraced in one county, sufficient to supply the people for ages. England, with a population of probably 15 millions, consumes about 18 millions of tons of coal annually. Ohio is supposed, at this time, to contain one and a half millions of people. Should the consumption of coal become proportionably as great as in England, there is sufficient in this county alone to supply the present population of our State with fuel, for 250 years.

Chemical and external characters. The iron ores indigenous to this region, are found principally in connexion with the shale. They may be classed in three varieties: argillaceous, calcareous, and silicious as the three earths, clay, lime, and sand, predominate. The ore, also, appears under different forms. The brown oxide of iron is the most abundant. In color it is brown inclining to grey, is destitute of magnetic properties, and seldom displays a metallic lustre. The argillaceous oxide of iron is also very abundant. The most usual form under which it appears is that of nodules. They are composed of concentric layers formed around a nucleus. The matrix in which they are imbedded is shale. These nodules often contain small quantities of lead, zinc and manganese, and also, crystalized carbonate of lime, and sulphate of barytes. Impressions of arundinaceous plants are not uncommon. When exposed to the air, the nodules absorb oxygen and peel off in concentric layers.

Range and extent. In the eastern part of this district we meet with few traces of iron ore, but the eastern part of Licking and the western part of Muskingum are amply stored with this material. The best beds lie between the conglomerate and the buhr—or a hundred feet above it. No valuable beds have been found out of the borders of the coal measures.

Near Col. Peairs' (Sec. 8, Salt Creek) there occurs a rich oxide of iron, the thickness of which I did not ascertain. Some of the blocks, which had been washed out of the hill side, were 4 or 5 inches thick.

At Zanesville, two beds are found; the one is a nodular iron ore, and occurs about 20 feet above the bed of the river, in shale. Almost every nodule contains calcareous spar and zinc. The second bed is found in connexion with a stratum of imperfect buhr, at the water's edge. It is compact, with a metallic aspect, and yields probably 60 per cent of iron. At the top of Putnam Hill, occurs an iron ore, disseminated through the sandstone, in small globules. It was supposed to contain copper. I applied the usual tests, but could not detect a trace. (For the result of the analysis of this ore, vide appendix to Prof. Mather's report.) There are two other beds in addition to those above described. These beds occupy an area equal to 200 square miles, embracing the western townships of Muskingum and the eastern townships of Licking. Little doubt exists that good beds of iron ore will be discovered on minute examination, on Flint Ridge, as the ground is sufficiently elevated to take two or three of the lowest. The section appended to the buhr, will show the order of their arrangement at that place. One or more of these beds may probably be found on almost every section west of the Muskingum. At Dillon's Furnace, near the centre of Falls township, three of these beds are worked. To show the order of their arrangement, I will introduce the following section taken in that vicinity, by Dr. Hildreth.*

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* Rep. to the Legislature, p. 10, 1836.

No.		FEET.
1.	Nodular iron ore	4
2.	Sandstone	10
3.	Limestone	4
4.	Coal	1
5.	Slaty sandstone and clay	80
6.	Iron ore	1
7.	Hornstone	0.5
8.	Cannel coal	2.5
9.	Sandstone	40
10.	Iron ore	2
11.	Sandstone and shale	30
12.	Iron ore	1.5
13.	Sandstone	30
		206.5

Bed of Licking.

Nos. 1 and 6, are identical with the beds found at Zanesville. No. 10, is a rich argillaceous ore of a brownish hue, extensively used. No. 12, is a calcareous ore, which, when mixed with others, serves as a flux. These beds at other points, are worked to supply the Granville and Mary Ann furnaces, in Licking county.

The western portion of Muskingum will afford the best sites for furnaces and foundries. The coal for smelting, and limestone for fluxing, can be readily obtained.

The ores are rich—yielding probably from 30 to 60 per cent. of iron, and easily wrought. I estimate their amount in round numbers, at 153,600,000 cubic yards, which, when smelted, will yield nearly that number of tons in pigs.

Process of reduction.—The ore is first broken into small blocks and placed in an oblong pile with layers of charcoal. It is then ignited and suffered to smoulder for a week. This process is called *roasting.* The ore becomes changed to a reddish brown color, its weight is diminished nearly one fourth, and the sulphur and carbonic acid gas are driven off. It is then mixed with certain proportions of charcoal and limestone, regulated by the quality of the ore, and placed in the furnace, which constitutes a *charge.* The limestone, acting as a flux, unites with the impurities of the ore, and rises to the top in the form of a *slag.* The particles of metal being denser than the surrounding mass, fall to the bottom, while the slag above protects it from the air. The process is never successful, says Dr. Turner, unless the flux, together with the impurities of the ore, are in such proportion as to constitute a fusible compound. The mode of accomplishing this object is learned only by experience: and as different ores commonly differ in the nature or quantity of their impurities, the workman is obliged to vary his flux according to the composition of the ore with which he operates. Thus, if the ore is deficient in silicious matter, sand must be added; and if it contain a large quantity of lime, proportionably

less of that earth will be required. Much is often accomplished by the admixture of different ores with each other.* The metal is next drawn off into a trench, and forms what is called *cast iron.* In this state it contains considerable portions of carbon and earthy impurities, which render it brittle and easily fusible. To make it malleable and tenacious, it is again fused, while a strong current of air is permitted to play over its surface. The carbon is consumed and the earthy impurities rise to the top. As its purity increases, its fusibility diminishes. When it stirs in thick pasty lumps, it is taken out and beaten into cakes. The effect of beating is to increase the proximity of the particles and thereby render it more tenacious. It is subsequently heated and beaten out into bars. This constitutes the *bar iron* of commerce.

Pyrites, or sulphuret of iron, is found in most of the shale beds. It also penetrates the fissures of the coal, in films of a bronze or brass yellow color. In the sandstone which forms the bed of the canal at Zanesville, it is found in spheroidal masses, some of which are perfect globes, resembling cannon balls. Near Chandlersville, it is disseminated through a limestone in minute yellow particles, and also invests the outside in granular concretions. Mr. S. Bliss, of Brush creek township, formerly manufactured it into copperas. The process is this: the ore is exposed to the atmosphere and moistened. Heat is generated—the sulphur absorbs oxygen from the atmosphere, and is converted into sulphuric acid. This, uniting with the iron, forms a sulphate of iron or *copperas.* It is subsequently leached and crystallized. The iron is converted into a red ochre, and may be used as a pigment.

BUHR.

This is the result of a chemical precipitate—rather than a mechanical deposit—of silex; although we are unacquainted with the process by which it was effected over so large an area. That silex is soluble in boiling water, is evident from the deposits of the geysers of Iceland and Bohemia; nor is a high temperature absolutely necessary, since it enters largely into the composition of most of our canes and rushes.

External Characters.—Greyish or yellowish white—also with a greenish tinge; opaque—sometimes passing into hornstone, when it becomes translucent. It contains numerous cavities—bearing some resemblance to amygdaloidal trap. These cavities, in some cases, are formed by the mould of small infusoria, myriads of which are contained in a cubic foot.

Mineral Contents.—Quartz in beautiful druses, lining the oblique fractures of the buhr—also in six-sided pyramids—occasionally smoky. Chalcedony in a confused aggregation of crystals, in the cavities of the buhr, as though deposited by infiltration before the consolidation of the surrounding mass was complete. Calc spar, in rhombic prisms

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*Elements of Chemistry, p. 329.

of a pearly lustre—translucent, or nearly transparent. Heavy spar, or sulphate of barytes, is also found.

Organic Remains.—These do not indicate a different geological age from the adjacent rocks. They are, however, found in great perfection and beauty. The commonest fossils are terebratulæ, encrini, anthophylla, spirifera, producti and the infusoria before spoken of. Trilobites have been found in a limestone on Flint Ridge. I am not aware that this fossil has before been observed in the coal measures. Its occurrence under such circumstances shows that it flourished here, long after it had ceased to exist in other countries.

Range and Extent.—Beginning about a mile west of Somerset, Perry county, it ranges near the dividing line between Muskingum and Licking, passing through the townships of Hopewell, Hanover, Licking and Jackson, crossing the national road near Gratiot. Its average breadth is from 8 to 10 miles. This rock is so liable to disintegration, as to render it difficult to ascertain the line of junction. Its examination, therefore, is attended with some degree of difficulty. To specify all the localities at which it has been observed, would be unnecessary as they are indicated by symbols on the map.

Economical uses.—It is quarried and wrought into mill stones. The principal quarries are those of Samuel Drumm and S. Henslee, on sec. 15, Hopewell township, Muskingum county; and Adam Drumm and Joseph Baird, on sec. 11, Hopewell township, Licking county. It is inferior in toughness to the Raccoon buhr, and therefore less valuable for mill stones. Some varieties might be wrought into oil stones—being similar to the material used by Mr. McDougal, of Athens county. Suitable materials for this purpose were observed about one half of a mile northeast of the residence of Mr. Drumm, on sec. 14. The stone is white, fine-grained and compact, and well calculated to give a keen edge to tools. The aborigines formerly used the compact hornstone for spear and arrow heads. They seem to have been aware that it worked more freely when dug fresh from the earth, than after exposure to the air. For this purpose, they stripped off the earth to the depth of 8 or 10 feet. Excavations of this kind, occupying acres in extent, occur about 3 miles west of H. Lear's, on the Flint Ridge road. Their number and extent indicate that this was a favorite place of resort with the Indians, for procuring implements of warfare. I have observed similar excavations in Jackson county, but less extensive. These "diggings" as they are provincially termed, many believe were made in search of the precious metals. This opinion is prevalent along the whole region traversed by the buhr, and money and labor have been freely expended in fruitless explorations. The "mineral rod" too, has performed its part in propagating the delusion.

Inclination.—Conformable to the adjacent rocks.

Thickness.—From 2 to 6 feet.

Note.—To show the relation between the buhr and the associated rocks, I will subjoin the following section, on the land of Joseph Baird, sec. 11, Hopewell township, Licking county:

	FT.	IN.
1 Buhr	4	
2. Shale	10	
3. Hornstone	1	4
4. Grey cherty limestone	5	
5. Shale—dark	30	
6. Shale—light blue	10	
7. Coal		8
8. Shale—light blue	10	
9. Slaty sandstone	8	
10. Yellow shale	15	
11. Iron ore		8
12. Shale—dark	10	
13. Iron ore	1	4
14. Limestone—brown	5	
15. Light blue limestone	6	
16. Compact sandstone	40	
	157	

The iron ores, in this section, are of a good quality, and probably a continuation of the beds wrought at Dillon's furnace.

SHALES.

Shale is one of the most abundant rocks in this series. It forms the matrix of most of the iron ores, and the roof of most of the coal beds. Its colors are yellowish, pale blue, and black. Some of the beds are so highly impregnated with bitumen, as to be inflammable. From the quantity of pyrites intermixed, they disintegrate on exposure to the air.

Economical uses.—Alum, or sulphate of alumine and potash, is found in many of the shales, but has not been observed in sufficient quantities to be of much economical value. The clay resulting from their disintegration, is used in pottery a few miles west of Zanesville, on the national road. It is extremely plastic and free from grit. The articles manufactured here, are of a superior kind and command a good price. I was unable to gather any statistics as to the amount of pottery manufactured at the various establishments, or the nett proceeds resulting from the sale. Some of the clays in connexion with the coal, are white and almost unctuous to the touch, and I doubt not, on experiment, they will make good *fire brick*. Common clay abounds in every part of the county to such an extent as to render it needless to specify localities. It is generally mixed with more or less silicious earth—derived from the associated sandstones. The brick made of this material, in Muskingum county, is not of a superior quality. This is attributable not so much to any defect in the material, as want of care in the manufacture. The best brick contain about one proportion of sand to three of clay, and to enable them to stand the vicissitudes of the weather, they should be thoroughly burned, almost to vitrification.

LIMESTONES.

There are at least eight beds of limestone in this series. The uppermost bed is found near the summit of Norwich hill. It is non-fossiliferous, and quarried to some extent for the national road. It has the appearance of having been made up of the fragments of pre-existing rocks.—Thickness, three feet. The second bed is about 100 feet below, and contains numerous marine shells.—Thickness, two feet. The third crops out about 100 feet above Big Salt creek, where it is quarried for the road—on the land of Mr. Henderson. It is of a buff color, destitute of fossils, and does not calcine.—Thickness, six feet. A bastard limestone is found near Jackson, a few feet below the coal, where it is quarried for the road. A limestone occurs on the land of Mr. Pringle, about four miles south, under like circumstances, which I think the equivalent of this bed. On the summit of Putnam hill, a thin bed of limestone occurs, of a buff color, and fossiliferous. About sixty feet below there is a bed of blue limestone, which is extensively quarried for burning. It can be readily recognized by the encrini which accompany it through its whole course—some of which are two feet in length. It extends as far west as Mt. Sterling, and is the most valuable stratum in the district.—Thickness, four feet. In the bed of the Muskingum there is another stratum, of a dark blue color, which affords an excellent material for curbing. This stratum contains large uniones, in a beautiful state of fossilization. One peculiarity about this rock is, that it breaks into quadrangular blocks. I have noticed this in the beds of the Muskingum and Moxahala, where large surfaces are exposed. I also noticed it on the farm of Col. Chambers, where the rock is laid bare in the bed of a run, for a distance of 100 yards; the blocks are as regular as though fashioned by the hand of the mason. The next bed of limestone crosses the national road near Kent's run, and a good section can be obtained on the the land of Mr. Green, where it has been quarried to a considerable extent. It is blue, and contains few fossils.—Thickness, fourteen feet. The last bed noticed, is found near Brownsville. It is fissile in its structure, contains marine shells, readily crumbles on exposure, and is intermingled with chert and shale. As a material for roads it is comparatively worthless.

Economical uses.—Most of these beds calcine into lime, and afford the best material for roads which this region contains. Great caution, however, should be exercised in their selection. The observer should recollect, remarks De La Beche, that the stones placed upon roads are exposed not only to friction, but the pounding or crushing action of the weights which roll over them, and consequently, that a tough as well as a hard substance is required. Rocks differ exceedingly in these qualities, and those persons who have paid attention to the kind of stones thrown on roads, must have remarked how frequently hard stones are preferred by surveyors and others, when tough materials were to be obtained equally near and cheap.*

* How to Observe, pp. 299, 300.

SANDSTONES.

These beds appear to be composed of sand, sometimes united by a calcareous cement; sometimes by an oxide of iron; but more frequently by concretionary action alone. Their toughness and compactness depend upon the degree of crystallization.

There are several beds of good sandstone in the region examined. On the dividing ridge between Salt creek and Buffalo fork, in the townships of Rich Hill and Meigs, a thick bed of sandstone makes its appearance. This ridge is among the most elevated points in the county, and from it the eye ranges over an expanse of twelve or fifteen miles. The sandstone is scattered over the surface in large isolated blocks, as though they had been reft from the parent bed by some disruptive force. Some portions of this rock resist the weather, while others crumble rapidly when exposed. The atmosphere may form a chemical combination with the substances in the rock, since it contains, in many places, salt petre or nitrate of potassa, in considerable quantities. A natural bridge, with a span of 18 feet, has been formed on this ridge from the disintegration of the rock.

Near Cumberland a beautiful flagging stone is quarried, which splits in smooth faces and is very durable. The sand is fine and the mica disposed in horizontal plates, so that it fractures in flat surfaces.

A durable stratum of sandstone crosses the national road near Big Salt creek, which is compact and homogeneous in its structure.

Two strata of sandstone are found at Zanesville, from which vast quantities of stone are taken for the public works. The principal quarries are Mathews', Burwell's, Spaulding's, Monroe's and Roberts'.

Above Zanesville this rock comes to the river in bold precipitous scarps, and in many instances, their bases have disintegrated so as to form deep coves and grottoes.

Near Dresden it is quarried and transported to Zanesville, where it is used in the manufacture of crown glass, at the works of Mr. Robinson. The best material for this purpose, is that which is destitute of mica and oxide of iron. It is first burned and then crushed under a roller.

Ripple marks are found on many of the sandstones. The most distinct observed, are on the fissile sandstone at the head of Market street. The furrows are in some cases deep and in others gentle, in proportion to the agitation of the water, at the time of their formation. The undulations are so perfect and entire, that the beholder is impressed with the belief that he sees before him the bed of the primeval ocean.

These sandstones constitute the principal building material in this section of the State, and evidences of their durability may be seen in the culverts and bridges on the national road. The underpinning of the court-house at Zanesville, though exposed to the vicissitudes of the weather for a period of 30 years, is as perfect as when first laid.

SALT SPRINGS.

These originate in this series of rocks, and may, therefore, be properly described under this division. Dr. Hildreth has written so lucidly

and minutely on this head, that I have few additional particulars to communicate.

Legislation on the Salines. Among the propositions submitted by Congress to the people of the Eastern Division of the North Western Territory, one was, that the six miles reservation including the salt springs, commonly called the Scioto salt springs, the salt springs near the Muskingum river, and in the Military Tract, with the sections of land which include the same should be granted to the said State, for the use of the people thereof, the same to be used under such terms and conditions as the legislature of said State should direct: *Provided*, That the said legislature should never sell nor lease the same for a longer period than ten years, (vide act of Congress 1802, §7. 1, Chase's stat. 72.) This proposition was acceded to by the convention, which met at Chillicothe on the first Monday of November, 1802.

In 1804, the legislature directed that a person should be appointed to make a careful examination of the Muskingum salt springs—ascertain the strength and quantity of the water, and the extent and space in which it was to be found (2, O. L. L. 113.) In addition to this, he was authorised to lease the springs for a period not exceeding one year. In an amendatory act of 1809, the agent was instructed to give the preference to those who had made improvements on the salt reservations. (7, O. L. L. 144.) The Governor was authorised to appoint the agent to lease the springs and collect the rents. (Ib. 213.) In 1810, Thomas Sarchet, sen., John Sarchet and Peter Sarchet, jr., were authorised to occupy the Muskingum salt works for three years at the rate of $60, with a proviso, that the rent should abate if they succeeded in the substitution of stone coal in the place of wood. (8, O. L. L, 215.) In 1812, the legislature directed the rent should be reduced to $50, if they succeeded in procuring water of such strength that 600 gallons would make a bushel of salt. (10, O. L. L. 126.) In 1814, the legislature passed an act, releasing them from the provisions of the preceding acts. Thus far, the salt springs had not been productive of revenue, either to the lessees or the State. Water of greater strength had been procured on the Muskingum, so that the state works were profitless. Accordingly, in 1826, the consent of Congress having been obtained, the Legislature directed that the Salt Reservation in Muskingum county, be surveyed and exposed for sale on the July following.

Range and extent.—Borings for salt water have been made all along the Muskingum river in this county, at short intervals; also, on Moxahala, Licking and Salt creeks. In every instance, I believe, water has been procured; but in many instances it was so deficient in strength or quantity, as to render it unprofitable to evaporate. Not less than 50 wells have been bored in this county alone. As a general thing the water increases in quantity, in descending the river and is reached at a greater depth, which is nearly conformable to the inclination of the strata. The wells at Taylorsville are sunk about 450 feet; but one was sunk more than 800 feet, without procuring an additional quantity of salt water. At Chandlersville, the depth of

the well is about 350 feet; at Zanesville, 258 feet; six miles above Zanesville, about 200 feet.

Chemical Composition.—Few, if any, of the salines have been made the subject of analysis. A notice of the ingredients of the water as well as the proportions in which they exist, will be deferred to another time.

Temperature of the wells.—The temperature of the salt wells is, so far as I have observed, higher than that of fresh water wells. I have made but two experiments—and those on the same wells.

1.	Temperature of the atmosphere	92°	Fahr.
	" " a salt well 400 feet deep	63°	"
	" " fresh water well 30 feet deep	58°	"
2.	" " atmosphere	58°	"
	" " salt well	55°	"
	" " fresh water well	54°	"

Dr. Hildreth states* that "on applying the thermometer to one of the deepest wells at McConnelsville, being 819 feet, the water as it rushed up from the bottom of the well was found to be only 52° which is very near the mean temperature of the spot. In a well 400 feet deep, the water as it rises is 50°, and in a fresh water well 40 feet deep 53° near by the salt well."

From these experiments, we can derive nothing satisfactory. The temperature varies in different wells, and these variations are far from being constant and uniform, even in the same well.

Origin of the Salt Springs.—The most plausible theory as to the origin of salt is, that it was deposited from the waters of the primeval ocean. "It is not difficult to imagine," remarks Dr. Beck "that these waters may have remained in various places after the general subsidence, and that by long continued evaporation they have been brought to the state of concentration which we find in the brines. The extent to which this evaporation must have been carried, in the present instance, will appear from the fact that sea water rarely contains more than four per cent of saline matter."† The salt, I am led to infer, exists in minute particles in the rocks, is dissolved by the water percolating through the incumbent strata, and comes to the surface in the form of brine. An opinion exists among the borers that the brine is confined to particular strata—they speak of an *upper* and *lower* salt rock. So far as our observations extend this is incorrect. It has been found in the mountain limestone, at Delaware, and in the shale imposed upon it at Circleville and Chillicothe. The brine at Jackson issues from the conglomerate. Fragments of this rock in some cases when exposed to a moist atmosphere are incrusted with salt. The borings at the latter place also extended into the fine grained sandstone. The wells in Hocking Valley and probably the deep wells in

* 24 vol. S. J. p. 67.

† N. Y. Geol. Rep. 1838, p. 14.

Morgan county extend into the conglomerate, while the wells above Zanesville probably do not reach it. The reason why brine is found in sandstone, is that is so porous that water permeates freely through it, while the shales and limestones, being impermeable, form a water-bearing level and create subterranean reservoirs in the sandstone. The conglomerate, from the porousness of its structure, admits of a free passage for water, which dissolves the saline ingredients, and is the source from which we should expect the greatest supply of brine.

SALT WELLS.

The following list comprises the principal wells which have been bored in Muskingum county. Those which are worked, are indicated by an asterisk:

NAMES OF WELLS.	SECTION.	WHERE SITUATE.
* Henderson's - - - -	32	Blue Rock township.
* West's - - - - -	32	do.
Dillon's - - - - -	32	do.
* Findley's - - - - -	8	do.
* Culbertson's - - -	30	do.
" - - -	30	do.
* " - - -	29	do.
* Roberts' - - - - -	17	do.
* Ayres' - - - - -	20	do.
* " - - - - -	17	do.
* " - - - - -	8	do.
* Johnson's - - - -	9	Brush Creek township.
* " - - - - -	9	do.
* Neff's - - - - -	8	do.
* Whittaker's - - -	8	do.
* Swingler's - - -	17	do.
* Bliss's - - - - -	6	do.
Lenhart's - - - -	17	Newton township.
Stokeley's - - - -	34	do.
* Neff's - - - - -	32	Salt Creek township.
* Chandler's - - -	29	do.
Sarchett's - - - - -	14	do.
Chandler's - - - - -	14	do.
* Groves' - - - - -	32	do.
* Taylor's - - - - -	30	do.
——— - - - - -	32	do.
* Taylor's - - - -	30	Wayne township.
Dillon's - - - - -	6	do.
* Ayres's - - - - -	10	do.
* " - - - - -	10	do.
Davis's - - - - -	22	Perry township.
Whipple's - - - - -	1	Springfield township
Granger's - - - - -	5	do.

NAMES OF WELLS.		SECTION.	WHERE SITUATE.
Culbertson's -	- - - -	5	Zanesville township.
Pierce's	- - - -	5	do.
Hampson's, -	-	southwest part of Washington township.	
* Blocksom's,	-	" "	do.
* Burwell's, -	-	" "	do.
" -	-	" "	do.
" -	-	" "	do.
* Burbridge's,	-	" "	do.
* Herrick's, -	- - - -	east part of Falls township.	
" -	- - - -	" "	do.
Chambers', -	- - - -	" "	do.
Dillon's, -	- - -	centre	do.
Jackson's, -	- - -	east part of Muskingum township.	
Mape's, -	- - -	northeast "	Madison township.

This list includes 47 wells; there may be two or three which have escaped my observation. Twenty-six of these are worked to a greater or less extent. Some of these wells produce 10,000 bushels of salt per year, while others produce one half of that quantity. We will suppose that, on the average, each well yields 4,000 bushels per an'm. Adopting this as the criterion, the amount of salt annually manufactured in Muskingum county, would equal, in round numbers, 100,000 bushels. This, at 40 cents a bushel, (the price for the last two or three seasons,) would amount to $40,000 00.

I found it impossible to obtain from the manufacturers, any statistics as to the quantity annually made. In the absence, therefore, of positive data, I have resorted to a mode which can be regarded only as an approximation to the truth. It is desirable that the manufacturers keep statistical accounts of the amount annually made.

Process of Manufacture.—The water is pumped by means of horse power, from the well into a large cistern, from which it is conducted by pipes, with stop-cocks, to the kettles where it is evaporated. These kettles are elevated three or four feet above the ground, under which passes a flue. Coal is employed at most of the salines, for effecting the evaporation. After having been reduced to a certain degree, the brine is transferred to a cistern, where it deposites a red ochrey sediment; it is then placed in the graining kettles, together with a small quantity of beeves' blood. The impurities rise to the top and are skimmed off. When the water has evaporated, the salt is transferred to an inclined trough, so that the bittern may run off; and is afterwards placed in a sheltered place where it is suffered to dry, previous to packing. Beeves' blood is, I believe, the only purifier added. "It is a very common practice," remarks Dr. Beck, "at the Onondaga works, to add lime to the brine contained in the reservoirs, and the same substance is also sometimes thrown into the kettles during the boiling of the salt. The addition of lime, if properly made, expedites the process of manufacture, and does not, in the least, impair the purity of the salt." "I should observe, however, that the advantage gained by the use of lime,

depends upon its purity and the time allowed for its precipitation before the salting commences. When added to the salt during the boiling, it impairs its purity, and may be a fraudulent operation unless great care is taken in again removing it by the pans with which the kettles are supplied. The correctness of these views will be evident on recurrence to the changes which the addition of lime causes in the composition of the brine. The excess of carbonic acid which holds in solution the carbonate of lime and oxide of iron in the raw brine, combines with the added lime and causes a deposit of the whole insoluble carbonate. Moreover, the lime decomposes the chloride of magnesia, and there result chloride of calcium held in solution, and magnesia precipitated." "It seems to me, therefore, that there can be no good objection to the use of lime, if it be confined to the reservoirs, as it causes the more speedy separation of the earthy matters, and renders the subsequent salting more rapid and perfect. But I would repeat, that in order to secure its beneficial effect, the lime should be in as caustic or pure a state as it can be conveniently obtained." "With regard to the addition of this substance while boiling, I can only say, that if the resulting earthy matters be carefully removed, its use may be tolerated; but it cannot be concealed, that in such cases there is a strong temptation to hurry the process to completion, and thus to mix up the earthy ingredients with the salt."*

Carburretted Hydrogen gas is disengaged from nearly all the salt wells, in considerable quantities. *Petroleum*, or mineral oil, is contained in some of the wells at Norwich, in such quantities as to render it highly disagreeable to the taste.

CONGLOMERATE.

The coal measures repose on a formation, to which the name conglomerate, or millstone grit, has been applied. It is composed of quartzose pebbles and coarse-grained sand agglutinated together—the debris of primitive rocks. This is its general character; but in many places it assumes a finer texture, and passes into a hard, compact sandstone, with few pebbles interspersed. From the Ohio river, near Portsmouth, to Licking river, it is found at short intervals, cropping out in abrupt, precipitous ledges. About 5 miles from Nashport, where the canal enters the Licking, the conglomerate appears under circumstances of peculiar beauty. The cliffs rise to the height of nearly 100 feet, and are crowned by a luxuriant growth of forest trees. They sometimes project over 30 or 40 feet, forming spacious caverns or grottoes. In one place, a streamlet falls over a precipice in an unbroken cataract of about 80 feet, and is received in a basin which it has worn in the rock below. Nothing can be more grateful than one of these retreats during the sultriness of summer. "Black Hand," is a isolated mass of conglomerate jutting over the water, at the base of which, is excavated the towpath. It derives its name from a huge hand, (said

* N. Y. Geological Report, 1838, pp. 32-3.

to have been carved by the aborigines,) pointing over the stream, which was destroyed during the excavation of the towpath.

Rude delineations of animals are said to exist on this rock; if so, they escaped my observation. The conglomerate is also exposed by the race way, near the entrance of the gorge. There it dips to the N. N. E. at the rate of three feet in ten, or little more than 15°. Ripple marks, running nearly in the line of the dip, were observed as well as indistinct fucoides. It is stratified, breaking into layers from a few inches to three feet in thickness. For two or three miles along the Licking it is quarried, and is the material of which the locks on the canal, and many of the culverts on the national road are constructed. This rock extends nearly to Newark, and may probably be found capping the highest hills beyond. Where it crosses the national road, it looses, in a measure, its conglomerate character, and appears under the form of a coarse, hard sandstone. Constituting, as in all probability this rock formerly did, the delta of an ancient river, we ought not to expect a homogeneity of character, or uniformity of thickness; for, in the detritus brought down from the primitive mountains—of which the secondary rocks appear to have been formed—the pebbles would be deposited first, the coarser materials next, while the finer particles would be borne far out into the ocean. In some instances, this rock is made up of alternating layers of pebbles and sand; as though, in a turbid stage of the water, pebbles only were deposited, while, in a more tranquil state, nothing but comminuted sand was held in the current. The mean thickness of this rock is about 100 feet.

Organic Remains in the coal measures.—Throughout these mechanical deposits, are entombed, in great profusion, the relics of a former world. "These medals, as they have been aptly termed, struck by nature to commemorate her revolutions," disclose to us the history of the past; of the perpetual mutations which the earth has undergone in the uplifts of mountain chains, and the submersion of continents.

The remains in the sandstones, consist of the trunks of trees and gigantic arundinaceous plants. The most common are of the family Lycopodiceæ and Equisetaceæ. Several species of Lepidodendra have been observed, some of which are two feet in diameter, with their scaly stems as perfect as when first deposited. Some idea may be formed of the exuberance of the ancient Lepidodendra, from their analogues of the present day, which are generally creeping plants like the mosses, and rarely attain an elevation of 40 inches.

Calamites, of immense size, are also found, and the Sigllaria with its bristling spines standing out in every direction, perfectly preserved.

The shales afford the most beautiful and varied display of fossil ferns. The ground work is light, while the leaf is black; and every minute foliation and fibre is displayed in great perfection. I have observed several species of the Neuropteris, Sphenopteris and Pecopteris, some of which are undescribed, and three species of Asterophyllites, besides other plants, the generic character of which has not been ascertained. For this reason I have deferred giving a catalogue of the

vegetables which accompany the coal. Few places in the world, perhaps, afford them in such abundance and perfection as the mines about Zanesville. Many of the plates in the splendid work "*Histoire des Vegetaux Fossile*," by M. Adolphe Brongniart, were figured from specimens furnished him by the late Ebenezer Granger, Esq., or from drawings sent by W. A. Adams, Esq.,—all of which were procured near Zanesville. Among that collection were the Neuropteris Grangeri, named in honor of the first gentleman; and the Poacites lanceolata, vegetables which have been found only at Zanesville. Dr. Hildreth, also, in his admirable article in the 29th volume of Silliman's Journal, has figured several of the plantæ of this vicinity.

The limestones, which alternate with the coal measures, contain marine animals, the principal of which are spirifera, producti, terebratulæ and encrini, the latter attaining a length of two or three feet. No traces of vegetation have been observed in them, though the contiguous beds often contain plants in great abundance. The reverse, however, is not true, since marine shells have been observed in the shale and cannel coal beds.

Their occurrence, under such circumstances, indicates that the waters of the ocean must have been subject to mighty fluxes and refluxes; and when we consider the number and the minute sub-divisions of the intermediate beds, and the myriads of plants entombed, we are drawn to the conclusion that ages must have elapsed between the invasion and retrocession of the oceanic waters.

Range and extent.—Much of the matter which might, with propriety, be included under this head, has already been incorporated in the local details of this report. The rocks described, embrace but an inconsiderable part of the great coal formation of the Mississippi valley.

Inclination.—The strata generally incline to the E. S. E., at the rate of 35 or 40 feet per mile; consequently the line of bearing would be N. N. E. Col. Whittlesey, at my instance, made several measurements in the vicinity of Zanesville with a view of ascertaining the precise dip. For this purpose, we selected the blue limestone, which occurs in Putnam hill, as, from the peculiarity of structure, it could be easily identified at remote points, and measured it in four directions. The dip was found to be S. 87° E., at the rate of 47.85 feet per mile. This result is based on the following measurements:

1. From McIntyre's quarry to Roberts' quarry; N. 74° 30′ E., 1192.8 yards—descent 29 feet.
2. From McIntyre's quarry to the point of Putnam hill; S. 5° W., 1668 yards—horizontal.
3. From Putnam hill to Ballantine's mill; S. 55° 15′ E., 1,077 yards—descent 24 feet.
4. From the coal, by Putnam church, to the upper opening of coal above Ballantine's; N. 72° E., 931 yards—descent 26 feet.

This is, probably, greater than the mean dip. The strata are subject to local variations; thus, in the southeast part of Muskingum county, they dip to the N. W. At Black Hand, as before remarked, they dip rapidly to the N. E. They are, in every part of the district,

more or less undulating, as though they had been subjected to a gentle oscillatory movement when in a plastic state.

Thickness.—The thickness of the several members of this group, from the fine-grained sandstone to the highest rocks in the eastern part of Muskingum county, is, probably, between 1,200 and 1,400 feet. This can be regarded only as an approximation to the truth, since an actual measurement is impracticable.

Agricultural character.—The soil of the region traversed by the coal measures is well adapted to wheat, corn, and potatoes. Some of the best grain-growing regions in the State are on this formation. In the eastern part of Muskingum county, the hills are high and somewhat precipitous; yet, from the quantity of lime which the soil contains, they produce excellent crops of wheat, even to their summits. The bottom lands along the Muskingum river produce the best crops of corn, while, perhaps, the section traversed by the conglomerate is the best adapted to bulbous roots. The soil of Flint Ridge is naturally strong, producing good crops of wheat, and is well adapted to apples, peaches, &c. The decomposition of the strata which compose this assemblage of rocks, affords all the ingredients of a good soil. The sandstones afford silicious particles; the shales, argillaceous; and the limestones, calcareous. The only inquiry, therefore, is in what proportions these materials should be blended to render them the most productive. This can be done only by attending to the composition and constitution of soils. Where there is an excess of silex, clay is the proper remedy; where clay abounds, so that the soil becomes cold and heavy, silicious sand is the best remedy. Some soils may be unproductive where no apparent defect exists in their constitution. This may arise either from the presence of the salts of iron or an excess of vegetable matter. In such cases, the difficulty may be obviated by the application of lime. Quick lime is highly destructive to vegetation; but, in a mild state, or in the form of a carbonate, is highly advantageous. Quick lime, therefore, should be applied only when there is an excess of inert vegetable matter, and carbonate of lime where the soil is deficient in the calcareous principle.

Dr. Ure, in his Dictionary of Chemistry, has some valuable remarks on the subject of soils, from which we make an extract. "The soils which are most productive of corn, contain always certain proportions of aluminous, or calcareous earth in a finely divided state, and a certain quantity of vegetable matter. The quantity of calcareous earth is, however, very various, and in some cases, exceedingly small. A very fertile corn soil from Ormiston in East Lothian, afforded in a hundred parts, only eleven parts of mild calcareous earth; the finely divided clay amounted to forty-five parts. It lost nine in decomposed animal and vegetable matter, and four in water, and exhibited indications of a small quantity of phosphate of lime.

"A soil from the lowlands of Somersetshire, celebrated for producing excellent crops of wheat and beans, without manure, I found to consist of one-ninth of sand, chiefly silicious, and eight-ninths calcareous

marl tinged with iron, and containing about five parts in the hundred of vegetable matter. I could not detect in it any phosphate, or sulphate of lime; so that its fertility must have depended principally on its power of attracting principles of vegetable nourishment from water and the atmosphere. Mr. Tillet, in some experiments made on the composition of soils at Paris, found that a soil composed of three-eighths of clay, two-eighths of river sand, and three-eighths of the parings of limestone, was very proper for wheat.

"In general, bulbous roots require a soil much more sandy, and less absorbent than the grasses. A very good potato soil, from Varsel in Cornwall, afforded seven-eighths of silicious sand; and its absorbent power was so small that 100 parts lost only 2 by drying at 400 degrees Fahr.

"Plants and trees, the roots of which are fibrous and hard, and capable of penetrating deep into the earth, will vegetate to advantage in almost all common soils that are moderately dry, and do not contain a very great excess of vegetable matter.

"From the great difference of the causes that influence the productiveness of lands, it is obvious, that in the present state of science, no certain system can be devised for their improvement, independent of experiment; but there are few cases in which the labor of analytical trials will not be amply repaid by the certainty with which they denote the best methods of melioration; and this will particularly happen when the defect of composition is found in the proportion of the primitive earths."

IV. FINE-GRAINED SANDSTONE.

This group is made up of beds of sandstone and argillaceous shale, and probably, in its geological position, is a member of the mountain limestone formation. The evidence on which this opinion is founded, will be deferred to a future occasion.

Chemical and external characters.—This sandstone is made up of grains of sand finely divided, united sometimes by an argillaceous cement, but more frequently its consolidation is due to concretionary attraction alone. It color is white, yellowish, or purple, sometimes tinged blue. As a general thing, it breaks into layers, varying in thickness from a few inches to three or four feet. It contains, in places, oxide of iron and aluminous matter, which cause it to exfoliate on exposure to the atmosphere. Great care, therefore, is required in the selection of materials for construction. Perhaps no rock in Ohio, is so variable in its qualities as this. Those varieties which exhibit a bluish tint, or turn red on exposure, should in no case be used in construction where durability is required.

Range and extent.—This formation is a continuation of that described by Professor Briggs, as occurring at Piketon, Waverly and Chillicothe. In this district, its eastern boundary may be indicated by a line drawn from Jacktown, through Licking county, in an E. N. E. direction. Its western boundary may be indicated by a line par-

allel to the other, running a few miles west of Reynoldsburgh, in Franklin county. This belt is about 20 miles in width, occupying the greater portion of Licking and the eastern section of Franklin county. It is, in most places, covered over with a coat of superficial materials, noticed under the head of tertiary, so that its examination is attended with a great degree of difficulty, and is seldom seen at the surface, except where the water-courses have cut through this superficial coat. It is quarried at Reynoldsburgh, and is the material of which the abutments of the bridge over Black Lick creek are constructed. It displays the bluish tint before spoken of, and crumbles under the influence of the rains and frosts.

At Gault's tavern, one half of a mile east of Luray, it is also quarried. It is of a yellowish color and very fissile, so much so, as to impair its value. This rock is also quarried by Mr. Woodruff, about one and a half miles southeast of Newark, on the Flint Ridge road. The following strata were there observed:

STRATA.	FEET.
1. Coarse-grained sandstone, compact	1.5
2. Argillaceous shale	8
3. Fine-grained sandstone	20

Considerable quantities of stone are taken from this quarry and employed in Newark. It is of a yellowish color, and much better adapted to stand the vicissitudes of the weather than the varieties before described. It has also been quarried at several points near Newark and Granville. The stone is taken from a superior part of the formation, and resembles, in its external characters, that which occurs at Woodruff's quarry.

Organic Remains.—In the lower part of this formation, no organic remains were observed, but the upper part contains them in great beauty and abundance. They consist of encrini, ammonites, producta, terebratulæ, spirifera, and others, the generic characters of which have not been ascertained. The surfaces of the sandstone near Newark, in many instances, are completely studded with the joints of encrini, and present a varied and beautiful appearance. No vegetable remains have been observed in this district, but in the southern part of the State, I have seen beautiful impressions of fucoides.

Thickness.—No means exist of ascertaining the precise thickness of this formation on the line of the section, as it never swells out into ridges, and is rarely visible except along the borders of streams. It may, however, be estimated at 400 or 500 feet thick, which is much greater than the average thickness.

Inclination.—The inclination is nearly conformable to the accompanying strata. It may therefore be rated at 30 feet per mile to the E. S. E.

Economical uses.—Aside from its value as a building material, the finer varieties may be employed for grindstones and whetstones.

Agricultural character.—The soil resulting from the decomposition

of this rock, is sandy or loamy, with little calcareous matter intermixed. It must be recollected, however, that the greater portion of the district traversed by the fine-grained sandstone, is covered over with transported material, so that very little of the nourishment afforded to vegetation is derived directly from the disintegration of this rock. The superficial materials contain sand, clay and lime, in a finely divided state; the soil, therefore, is capable of great modification by varying the component parts. The farms which are based on this formation, produce corn, wheat, potatoes, &c. to which the soil is well adapted.

V. SHALE.

This formation consists of a thick bed of shale, separating the fine grained sandstone from the mountain limestone.

External characters.—It is black, or brownish black, in its color,—fissile—of a dull fracture, and emits an argillaceous odor when breathed upon. The odor arises from the oxide of iron intermixed, since pure shales omit no smell. In some places, it contains a small quantity of bitumen, and emits a fetid odor when breathed upon. This shale readily imbibes water and exfoliates on exposure to the air.

In connexion with the shale, occur masses of carbonate of lime, resembling septaria. They are of a spherodical structure, varying in diameter from a few inches to three or four feet. They also differ in their internal structure; some of them being amorphous masses, while others are made up of concentric layers, formed around original nuclei. Some of these are so surprisingly regular as to have been mistaken for cannon balls, and have been frequently employed as ornaments to posts.

Balls of iron pyrites are also imbedded in this shale, and can be obtained in sufficient quantities for the manufacture of copperas. The shale cliffs, in many places are covered with an efflorescence of alum, which results from the decomposition of the pyrites. The mineral springs, which abound in the region traversed by the shale, derive their medicinal properties from the solution of these salts.

Range and extent.—The line of junction between the shale and fine grained sandstone is near Big Walnut creek, in Franklin county. At that place, there is a section of nearly 25 feet exposed on the right bank of the creek, and it extends thence nearly to the Scioto river. It seldom comes to the surface, being covered with transported materials to the depth of 50 or 100 feet. About two miles north of Columbus, it is seen in a gorge. The best opportunity for observing it in the county of Franklin is, perhaps, on the Olentangy, near, Worthington, where a section of 70 or 80 feet is exposed, with septaria imbedded. This formation, probably, forms the underlying rock through a great portion of the Scioto valley.

Thickness.—The thickness of this formation, on the line of the section, is from 250 to 300 feet.

Inclination.—The inclination, according to Col. Whittlesey, is S. 81° 52' E., at the rate of 22.73 feet to the mile.

Organic remains.—No animal remains have been observed in this formation. A few indistinct impressions of vegetables, the generic character of which could not be identified, were noticed a few miles north of Columbus.

Agricultural character.—A cold, heavy, tenacious soil, made up principally of Clay. The remarks made on the agricultural character of the fine grained sandstone, are also applicable to this formation.

VI. MOUNTAIN LIMESTONE.

The series last described, reposes on a formation composed of beds of limestone to which the terms "Mountain" and "Transition," have been applied.

Chemical and external characters.—The color of this limestone varies from a light grey to blue. It is sub-crystaline in its texture, and is stratified in layers from a few inches to three or four feet in thickness, being divided by thin beds of clay or marl. It is also intermixed with chert or hornstone.

Range and extent.—The first place at which it emerges to the surface on the line of the section, is near the residence of Mr. W. Sullivant, about three miles west of Columbus. This is a part of the great limestone formation which underlies the whole of the Mississippi Valley, extending to the Canadas, on the north, to Maryland on the east, to Alabama, on the south, and Missouri, on the west, and occupying more than one million of square miles.

Economical uses.—In beauty and durability, this rock exceeds all others in the State. It is sufficiently compact to take a polish, and has been used in the construction of jambs, pillars and other ornamental work. It is the material of which the Penitentiary is constructed, and the piers of the bridge across the Scioto, at Columbus.

Organic remains.—Marine animals, belonging to the following families, have been observed in this formation in various parts of the State.

Of the Zoophytes, the *Caryophylla*, *Turbinola*, *Cythophyllum*, *Astrea* and *Favosites*.

Of the Mollusca, the *Spirifer*, *Terebratula*, *Productus*, and *Cardium*.

Of the Conchifera, the *Melania*, *Delphinula*, *Turretella*, *Orthoceratites* and *Ammonites*.

Of the Crustacea, the *Asaphus* and *Calymene*, and others, the generic character of which has not been ascertained.

At this stage of the survey, it has been deemed unnecessary to append the specific names, where ascertained, as the catalogue would be imperfect. Very many of the fossil plants and animals which occur in the formations of this State, are undescribed. In fossil botany and zoology, there is an ample field for the palæontologist.

CONCLUDING REMARKS.

In bringing to a close this report, I am aware that it contains many imperfections, but it will be recollected that the board, during the past

season, have labored under many disadvantages for the want of means to prosecute the survey with vigor and success.

I have also incorporated in the details of this report, some facts not strictly economical, because this was deemed the most suitable occasion to lay them before the community. From the local knowledge of individuals, I have derived much assistance during the past season. The valuable and exact maps of Muskingum and Licking counties, by Wyllis Buell, Esq., have greatly facilitated my labors.

Specimens illustrative of geology of this region have been deposited in the State cabinet.

From the details embodied in this report, it will be seen that this region is amply stored with those minerals so necessary to the wants and conveniences of man. The iron ores, the vast accumulations of fossil fuel and the salt springs will prove permanent sources of wealth, not only to the region which they pervade, but to the State. Spread over these deposits, is a soil of unsurpassed fertility, which yields to the husbandman a sure return. With such resources within her borders, and peopled with an enterprising and intelligent population, Ohio must, at no distant day, occupy an enviable rank among the States of the Republic.

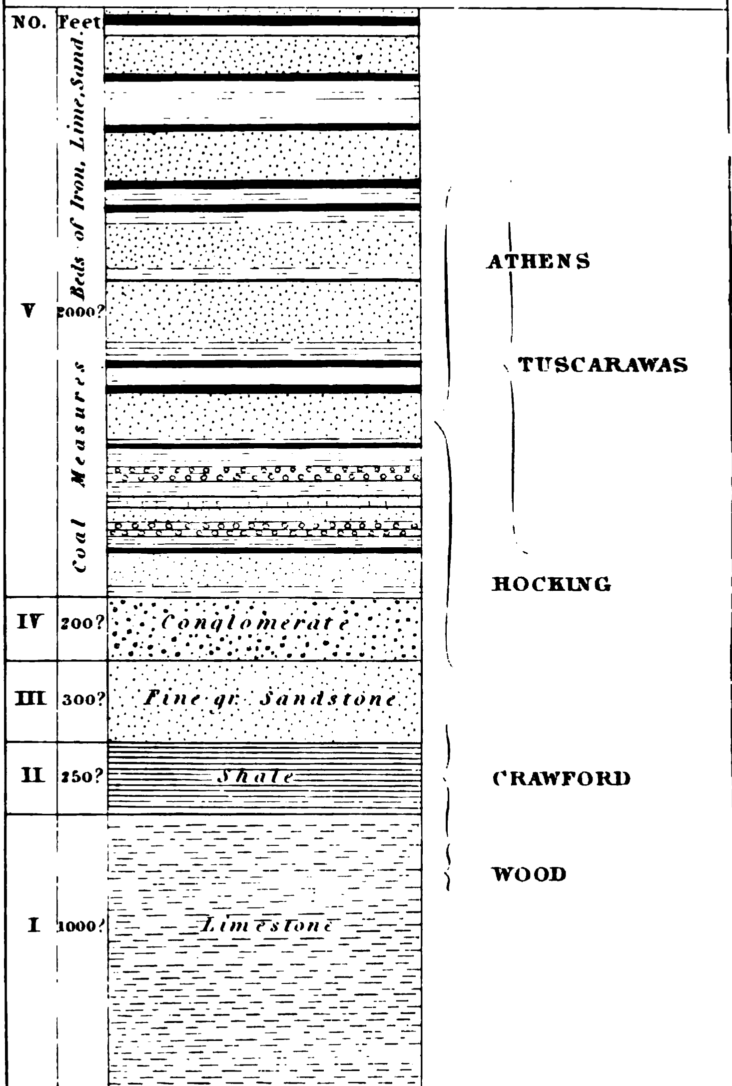
J. W. FOSTER.

NOTE.—*Explanation of the section.*—The section appended to this report is designed to represent the order of superposition in the different rocks, between the Scioto river and the eastern line of Muskingum county, a distance of about 70 miles. It has been compiled after repeated observations at different points, and is believed to be substantially correct.

The principal beds of coal and iron ore and limestone, together with the buhr, are indicated. I found it impracticable to put down the different beds of shale and sandstone, since they frequently alternate many times, at short intervals. The scale of length is 2 inches to the mile, and corresponds with the scale on which the county maps are constructed. The scale of height is 400 feet to the inch. In consequence of this double scale, the inclination of the strata is greatly exaggerated. Had I adopted a uniform one, it would have been difficult to represent the physical features of the region, and much more, the relative thickness of the different beds. For the line of the section, I selected the national road as the height of most of the elevations had been ascertained with a sufficient accuracy for the purposes of this section.

***SECTION** Showing the relative position and thickness of the strata in Ohio, and their relation to the Counties described in this Report.*

BY C. BRIGGS Jr.



J W Foster Del — Doolittle & Mu[illegible] Co.

REPORT OF MR. BRIGGS.

To Prof. W. W. MATHER,
Principal Geologist of Ohio:

The counties assigned me for examination during the past season, are Wood, Crawford, Athens, Hocking and Tuscarawas. They are situated in different parts of the State, and taken together, embrace not only the principal rock formations with their associated minerals, but almost every variety of soil in the State. Besides the detailed examination of these counties, in the discharge of my appropriate duties, I have collected many valuable facts relative to the geology of others, which will be incorporated in a future report.

The opinion is prevalent to some extent, that the eastern, or that portion of the State embraced in the coal measures, is only to derive a direct benefit from this survey. Such an opinion is erroneous.—The western counties will be highly benefited by an agricultural survey of their respective territories,—by analyzing the different soils, by bringing to light valuable beds of marl—and pointing out the best methods of cultivation. In this view alone, the direct utility which would result from the survey, would more than compensate for the cost. In addition to this, the western region of the State contains vast deposites of peat, bog iron ore and limestone, together with mineral springs, which will prove valuable for their medicinal properties.

That the reader may the better understand this report, it is deemed necessary to refer to the labors of last year. Accompanying my report of 1837-8, is a profile section, showing the relative position of the rock strata in the south and southeastern part of the State. The geological outlines as there indicated, I have found to be applicable, not only to that section of the State, but also, with a few local and unimportant variations, to that portion which has come under my observation during the present season. With the exception of the "calcareo-silicious rock" of Dr. Hildreth, the groups of strata as there described, have now been traced from the Ohio river, nearly to lake Erie. Individual and subordinate layers, it is true, could not be identified at remote points.

On the vertical section attached to this report, is indicated the geological position of the counties examined during the past season.*— These formations or groups, dip slightly to the east, or east southeast, and in traveling from east to west, across the State, we pass over their out-cropping edges, as they successively emerge to the surface.

I. The limestone deposite, indicated by this numeral, forms the rocky strata of the counties in the western part of the State. The point where it dips beneath the water courses and disappears beneath the incumbent strata of shale, sandstone, conglomerate &c., may be represented by an irregular line drawn from the east part of Adams county, on the Ohio river, to the quarries about three miles west of Columbus, on the Scioto; thence through Delaware, Marion and Crawford, to Seneca county. Here the line, inclining more to the north east, runs through the west part of Huron county, to lake Erie.

II. This division of the section represents a stratum of dark carbonaceous or bituminous shale, from 200 to 300 feet in thickness.

It is found along the Scioto valley, in the counties of Scioto, Pike, Ross and Franklin; on Alum creek, in Delaware county; on the Sandusky river, in the east part of Crawford; and also on the Huron river.

III. This division of the section represents what was described in my former report as the Waverly sandstone series. This fine-grained sandstone, which is of so great value in an economical view, I have traced through the counties of Scioto, Ross, Pike, Jackson, Pickaway, Fairfield, Delaware, Knox, Marion, Crawford, Richland and Huron.

IV. This division represents a formation to which the term conglomerate has been applied.† It ranges in a line nearly parallel to the preceeding division, and from its super-position in the series, is found a few miles east of the region traversed by the fine-grained sandstone.

V. This division embraces a series of beds consisting of sandstone, limestone, shale, coal and iron ore interstratified with one another, together with the "calcareo-siliceous rock" of Dr. Hildreth. The latter rock has been traced from the Ohio river through all the intermediate counties, to Coshocton and Tuscarawas. This division, which includes all the rocks above the conglomerate, aside from the superficial materials, is known by the name of the coal measures.

Having given a brief outline of the different formations in the State, I now proceed to detail the geological structure of the counties embraced in this report.

WOOD COUNTY.

It was my intention to complete a survey of this county in the early part of the season; but in consequence of the long continued and heavy

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*For a more particular description of these formations, see Ohio Geol. Report, 1837-8, p. 74.

† On the profile section attached to my report of last year, the conglomerate was erroneously represented as capping the hills west of the Scioto valley. This was a mistake of the delineator which escaped my observation. It is not improbable however, that this stratum may be found to cap some of the highest hills west of the Scioto.

rains, the investigations were postponed until the latter part of June. Even then, the waters, retained by a level and imperfectly drained country, rendered the examinations difficult and disagreeable. As I was anxious, also, to see the excavations which were to be made in the construction of the road from Perrysburg to Lower Sandusky, it was thought advisable to leave the completion of the survey of this county till the latter part of Autumn. But I have not been able to accomplish this, as I then expected. The most important part of the work, however, has been accomplished, and a few interesting localities only remain to be visited.

I would here acknowledge my indebtedness to Messrs. Davis and Smith, of Perrysburg. The former, as county surveyor, had visited every part of the county, and saved me much labor by directing my attention to such places as were worthy of examination. The latter, by his local knowledge and personal attendance during my examiations, rendered me essential services.

SURFACE OF THE COUNTRY—GEOLOGICAL POSITION.

By reference to the vertical section attached to this report, it will be seen that the geological position of Wood county is on the great limestone formation. The rock, though generally concealed, often lies near the surface, and seldom, probably, at a greater depth than 150 feet below it; over which is spread a coat of superficial materials, consisting of sand, clay, gravel, &c. The undulations of the surface are so slight that the whole county may be considered a vast plain, with a gentle inclination to the lake. The greatest elevations are not, perhaps, more than 60 or 70 feet above the water courses. The principal streams are the Maumee, Touissant and Portage. The former, is a beautiful, rapid river, forming the northwestern boundary of the county; the two latter are sluggish streams, watering the southeastern portion.

A large part of the county is occupied by a low, level tract of land, known by the name of the "Black Swamp." The soil supports a very dense growth of forest trees, among which beech, ash, elm, oak, cotton wood and poplar, most abound. The branches and foliage of this magnificent forest are almost impenetrable to the rays of the sun, and its gloomy silence remained unbroken till disturbed by the restless emigrants of the west. Here roads have been constructed, farms cleared, and houses erected in situations which a few years since it was supposed, unreclaimed by the hand of man, would always remain the peculiar abode of the reptile and the habitation of the wild beast.

Another portion of the county is composed of wet prairies, traversed by irregular ridges of sand; the former producing a heavy growth of prairie grass; the latter sustaining beautiful woodlands, called, in the language of the country, oak openings.

A few of the more southern townships are rolling woodlands, which, when cleared, will be well adapted to the cultivation of grain and grass.

The stratified deposits of this county will be described under the following divisions:

1st. Limestone deposit; and,

2d. Superficial materials by which it is covered.

I. LIMESTONE DEPOSIT.

The limestone which is found in this county, though not belonging to the superior part of the stratum, is not far below it. The rocky layers are generally concealed beneath the clays, gravel, loam, &c., which form the surface, but they are occasionally disclosed along the beds and banks of the principal streams, and sometimes in other situations, emerging to the surface, form narrow and slightly elevated limestone ridges. The rock is mostly destitute of organic remains where it has been examined; the only trace of them being a few fragments of radiated animals which were observed in the vicinity of Gilead. This limestone appears to be variable in external character and mineral composition at different places. In general, however, it may be described as a light colored, or yellowish silicious limestone; yet, in one or two localities, it contains little silicious matter, is darker colored, compact and slightly sub-crystalline. In some places the silicious particles in the limestone are so abundant that it might, with propriety, be termed a calciferous sandrock.

Economical uses—Locaclities of limestone.—The limestones of this county are not only of importance as affording good materials for building, but, perhaps, are still more so for agricultural purposes, for which they have not yet been tried.

They have been quarried and only used for the manufacture of quicklime, and as coarse materials for constructing buildings. There is little doubt that some of the varieties may be used for ornamental work.

Limestone of Maumee Valley.—This requires more careful examination than has yet been made. The bed of the Maumee river, with few interruptions, is limestone from the head of the rapids at Gilead, nearly to Perrysburg. Below the rapids—between the latter place and Marengo,—it has been quarried from the bank of the river at low water. Not far from this place, the limestone, for a short distance, forms the bed of the river. Two or three miles above Perrysburg, the rock has been quarried to manufacture quick lime. Here it occurs in layers from a few inches to a foot in thickness, and is sandy and light colored. Some of the slabs from this quarry can be used for flag stones. Between Miltonville and Otsego, the sandy variety of limestone has been used in the construction of a house, in which the material appears to endure unchanged, the vicissitudes of the weather.

Above this, at Otsego, the rock is well disclosed in the bed of the river, and continues with few interruptions to Gilead, where it is to be employed in the construction of culverts and locks, on the canal.—So sandy is the limestone, at this place, that it might, by the inexperienced, be mistaken for sandstone; and is so called by the quarrymen. In the bed of the river, a little below this quarry—and perhaps below it in geological position,—occurs a darker colored limestone, compact in its texture and slightly sub-crystalline. If obtained in blocks of sufficient size, it will make a handsome and durable building material. Some of the slabs are sufficiently compact, and free from impurities, to bear a polish; and though not very beautiful, may be

used for ornamental purposes. Specimens were procured with a view to a more particular examination of their value. The demand for this limestone will continue to increase with the progressive improvements in this section of the State, and many new quarries must, in time, be opened to supply it.

As the stratum which we have been describing, may be of as great value for agricultural purposes, as for those of construction, I have deemed it proper to subjoin the following list of localities in the interior of the county. Some of them I have personally examined; others were furnished me by Mr. Davis, the intelligent surveyor of Wood county.

Range.	No. of T'p.	Name.	Sec.	Remarks.
X	V	Plain,	36	S. E. qr.
"	"	"	25	S. E. qr.
"	"	"	24	S. E qr.
XI	VI	"	23	
"	V	Centre,	19	
"	"	"	30	Near the centre.
"	"	"	31	N. W. qr.
"	"	"	13	N. E. qr.
"	III	Bloom,	5	
"	"	"	6	On Sec. 6, in the bank of one of
"	"	"	19	the branches of Portage river, in
XII	VI	Troy,	5	a mill race near Woodbury.—
"	"	"	10	Thence, it extends E. into Sec. 5,
"	"	"	11	where it occurs in loose masses
"	"	"	12	on the surface. The rock may
"	"	"	14	be obtained in many other places
"	"	"	25	in this township, at a short depth
"	V	Freedom,	16	beneath the surface.
"	"	"	20	Rolling land b'twn. the branches of Portage R.
"	"	"	29	Bed of Portage river at Rochester.
"	"	"	10	" " "
"	"	"	11	
"	"	"	31	S. W. qr. Bed of Portage river.
"	IV	Mongomery,	1	Ridge running in S. E. and W. direction be-
"	"	"	12	tween the two sections.
"	"	"	27	Narrow ridge across the Sec.
"	"	"	26	
"	"	"	25	
"	"	"	32	S. E. qr. Branch of Portage R.
"	"	"	35	Ridge running N. E. and S. W.
"	"	"	36	
"	III	Perry,	4	
"	"	"	16	

The general character of the limestone has been described. At different localities, it is variable in character, owing to the variable proportions of the mineral ingredients. As a general thing, the light color and arenaceous texture predominate.

The localities mentioned in Troy township, constitute three or four distinct ridges, which cross the turnpike from Perrysburg to Lower Sandusky, in a N. E. and S. W. direction. These ridges are slightly elevated above the general surface, and the country between them is low and wet, being a part of the Black Swamp. The rock has been used for burning quicklime; also, for the foundations and back-walls of chimneys, for which, I am informed, it is well adapted,—the heat not being sufficiently intense to calcine the silicious varieties.

It is also valuable to the State, as affording materials for M'Adamizing the road, now in the progress of construction, through the Black Swamp. For this purpose, it would be more valuable if it were more compact, and less liable to crumble. It will, nevertheless, form a good material for the lower part of the road, where it will not be exposed to the crushing force of wheels. It is easily quarried and broken in pieces of a suitable size for roads.*

In these ridges, I think some quarries may be opened, which will yield good building materials. The more compact varieties take a polish, and though not very beautiful, afford a good material for door steps, window caps, jambs, mantle pieces, &c.

Mr. Smith showed me a piece of rather beautiful marble, polished, which was taken from a piece of land belonging to him, on the first limestone ridge east of Perrysburgh. This specimen was nearly white and compact. If it can be obtained in sufficient abundance, it may prove a desirable article for many purposes.

II. SUPERFICIAL MATERIALS RESTING ON THE LIMESTONE OF WOOD COUNTY.

These are, 1st. clays, sand, gravel and pebbles; 2d. boulders of primitive rocks; 3d. peat.

The first mentioned are spread over the stratum above described, so as to fill up the depressions in its surface, and give to this county, as well as those adjacent, the appearance of an extended plain. The limestone, as before remarked, rises through these materials in slightly elevated ridges, and is perhaps, in no instance, at a greater distance than 150 feet beneath them. These deposites vary in character, and composition at different localities. After repeated observations, I have been led to adopt the following as a general section of their arrangement.

1. Resting on the limestone is a *bluish clayey stratum*, in which are sometimes found pebbles of primitive and secondary rocks. At some

*If not too expensive, a most admirable road might be constructed by breaking the rock in pieces of greater size than those ordinarily used for McAdamizing, and filling the interstices between the fragments, with mortar made from hydraulic lime, or perhaps, common quick lime. In this way a road could be formed, which would be a solid layer of limestone.

localities, where the pebbles predominate, it assumes the character of a blue, compact, hard-pan, while at others, it is nearly free from these coarser materials. The average thickness of this division I do not know: it may vary from 5 to 100 feet; it is almost universally of a dark or bluish color.

2. Resting on the preceding, is a *yellowish clayey* stratum, sometimes containing pebbles of primitive and secondary rocks. In some places, it passes into sand and gravel, and in others these materials are wanting. It can be well examined along the excavation for the canal, a short distance west of Maumee city, Lucas county, nearly opposite Perrysburgh. The stratum here is a tough, yellowish, laminated clay, nearly free from pebbles. It effervesces briskly with muriatic acid, but, with the necessary care in burning, will make good brick.

Whether the two divisions just mentioned, are diluvium, or a part of the newer pliocene of Lyell, is still a matter of doubt. They are not confined to Wood, but form the superficial materials of all the counties in the western part of the State through which I have traveled. Both of the layers are generally penetrated in digging wells, and these are the best places for examining the strata. In Mr. Kelly's well, in the south part of Montgomery township, Wood county, the following arrangement of the materials was observed:

1. Surface loam.
2. Yellowish loamy clay, 10 feet.
3. Blue hard-pan, 15 feet.
4. Limestone.

The same deposites are found in the Black swamp; their average thickness, according to Dr. Riddell, is—

1. Dark soil, 1 foot.
2. Yellowish sand, 2 feet.
3. Blue hard-pan? 3 feet.
4. Resting on brownish yellow limestone.

The above examples are sufficient to illustrate the prevailing character of the superficial materials.

CLAYS.

The yellowish or superior stratum, upon which rests the soil, and from which it is in part formed, affords good materials for the manufacture of ordinary brick. Pebbles of limestone are often imbedded in the clay, which render it unfit for this purpose, unless carefully removed. They calcine, by burning and slacking, on exposure, cause the brick to exfoliate and crumble to pieces. This clay also contains carbonate of lime in a comminuted state, and oxide of iron in such quantities as to require great care in burning the kiln, lest it melt from the intensity of the heat. The clays which are the freest from these impurities, are best adapted to making brick. None have been observed sufficiently so for the manufacture of fire-brick or stone ware; but some may be found sufficiently pure for the coarser kinds. It is unnecessary to point out the different localities from which clays

may be obtained, as they abound in almost every township. Care, however, is required in their selection. The carbonate of lime can be easily detected by acids, whether it be in pebbles or in particles so finely divided as to be imperceptible to the eye.

SANDS.

Good sand here is of especial value: it is generally so intermixed with argillaceous matter that the mortar does not withstand the vicissitudes of the weather. Where a strong and durable mortar is required, the sand should be freed from the argillaceous matter by washing.

The most extensive deposites of sand in the county are found on the irregular ridges which traverse the wet prairies. It is a matter of doubt whether these ridges are a part of the yellowish loamy formation, before described, or a subsequent deposite. Some have suggested that they once formed the shore of the lake, but I think it more probable that they have been produced by the disintegration of sandy ridges of friable limestone. In process of time, most of the calcareous particles would be dissolved and removed by the carbonic acid of the surface waters, leaving it in the state in which it is now found. This conclusion is rendered probable from the fact, that when the silicious limestone approaches the surface, the soil is uniformly of a more sandy character. This is obviously the case on the farm of Mr. Hamilton, four or five miles west of Maumee city, in Lucas county. Here, in one or two places, the limestone is very friable, being composed mostly of silicious sand. It disintegrates by the action of frosts and rains, forming a light sandy soil. Some specimens of the rock are sandstone, as they do not effervesce by the application of acid.

BOULDERS.

Scattered over the surface, boulders of primitive rocks are occasionally seen. They are the most abundant along the Maumee valley, where I saw granite, gneiss, hornblende-rock, sienite, and some pieces of trap. They are generally rounded, and vary in size from a walnut to masses which will weigh from two to three tons. They have been brought to the situations in which they are now found since the materials on which they rest were deposited. These rolled masses are highly interesting in a scientific view; but it is not the province of the present report to discuss the causes which transported them from their parent beds, or the means by which their transport was effected.

PEAT.*

The only peat which I discovered in the county, is in one of the wet praries situated in the eastern part of Montgomery township.—

*For the examination of the wet prairies, in search of peat, marl, bog-ore, &c., I found it necessary to have an instrument construc'ed specially for the purpose. As I have found it very useful in my explorations, the following description is given, with the hope that it may prove useful to others. Since its construction, however, I find that Prof. Hitchcock has des-

This prairie is traversed by low, sandy ridges, between which the peat is deposited in places which formerly were small ponds, or a chain of ponds. Beneath the peat, where examined, is a blue argillaceous mud intermixed, more or less, with sand. This accumulation of vegetable matter appears to have been formed from the successive growth and decay of prairie grass, which took root in the argillaceous mud, as the ponds became sufficiently shoal to support vegetation.—This peat is not the most valuable for fuel, but may be profitably employed for agricultural purposes, of which, I shall have occasion to speak in another place. It is spongy, light, brown, and not sufficiently decomposed. In thickness it varies from 2½ to 5 feet, and occupies an area, as nearly as I could estimate, of 600 or 700 acres. It occurs on sections 13, 14, 21, 22, 23 and 24, and the amount may be safely put down at 600,000 cords.

WATER—SPRINGS.

The water from the wells and springs almost always contains carbonate of lime, and other impurities, which render it *hard*. Well water is sometimes chalybeate, and sometimes slightly charged with sulphuretted hydrogen.

I was informed that there are two mineral springs at Miltonville, on the bank of the Maumee river, but had not an opportunity of inspecting them, as they were overflowed by the river. There are comparatively few springs in the interior of the county; and though much of it is now too wet for cultivation, yet when improved, the inhabitants may experience great inconvenience, at certain seasons, for the want of water. This deficiency can, probably, be obviated by Artesian wells; and it may be found necessary, at a future day, to resort to this method for procuring water. The rock very frequently lies near the surface; and if it have any considerable degree of inclination, the water can be raised without boring to a very great depth.

BOG IRON ORE.

No bog ore was discovered in this county, though diligent search was made, in places where it was likely to occur. Small quantities, however, are said to have been found a mile or two from Gilead, at a locality which was not examined.

It may here be stated that this ore is said to occur in large quantities in Lucas county, four or five miles west of Maumee city. From

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cribed a similar instrument, for a similar purpose, in his able report on the re-examination of the geology of Massachusetts. This instrument, which may be called a peat or marl auger, is made of a grooved piece of iron forming half of a hollow cylinder, about one inch in diameter and two feet in length. The lower extremity is solid iron, forming a point, around which is cut the thread of a screw, the upper surface of which is a horizontal plane to support the peat, marl, &c. which may be drawn to the surface. The superior part of the instrument is a socket for the reception of a handle. By the use of this instrument, the thickness of beds of marl and peat can be ascertained, and materials for examination taken from any part of them. By means of the screw, bog-ore can be detected and brought to the surface for inspection. I have given this description, as valuable beds of marl and peat will be found in the western part of the State, and the above described instrument will aid the observer in ascertaining their thickness and quality.

a very slight examination of this locality, and the information derived from gentlemen who had visited it, I am inclined to believe that it is worthy of a careful exploration. Some of the ore was shown me by Mr. Sloane, Auditor of Wood county; and it appeared to be of a good quality.

CRAWFORD COUNTY.

Surface of the country, streams, &c.—The southern part of this county is on the dividing ridge between the waters of the St. Lawrence, and the Gulf of Mexico. The rains on the southern side of the slope are received by the tributaries of the Scioto, which flowing southward in their journey to the Atlantic, mingle with the Ohio, Mississippi, and other great rivers of the west; while those which fall on the northern declivity, collected by the Sandusky, flow in an opposite direction to Lake Erie, in their passage to the Gulf of St. Lawrence.

The greater portion of the surface is undulating, and gently inclined towards the lake. The greatest elevations are seldom more than 30 or 40 feet above the surface, and rarely, if ever, more than 60 or 70 above the water courses. The undulations are so numerous, that the country is well drained; and there is therefore little of the surface not susceptible of cultivation.

The principal streams are the Sandusky and its tributaries,—the Tymochtee, Sycamore and Broken Sword. The Sandusky enters the county on the east, and flows southwesterly about 20 miles, to the line of Marion; thence in a westerly direction for a few miles, when it bends to the north, and runs through the county, dividing it into two unequal portions. That on the south and west, is a beautiful prairie country, diversified by groups and clusters of oak and hickory; while that on the north and east of the Sandusky, sustains heavy woodlands of oak, beech, maple, sycamore, ash and elm. The valley of the Sandusky is narrow and slightly depressed below the general surface in which it is merely an irregular groove for the purpose of drainage.

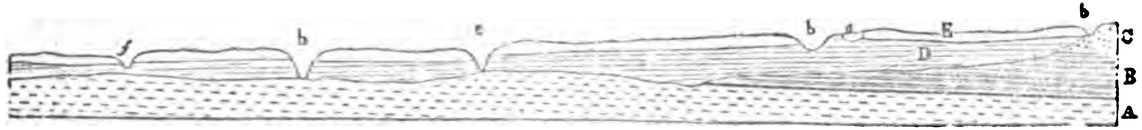
Geological position.—The geological position of this county can be observed on the section before described. It embraces the great limestone deposite, the shale, and a portion of the fine-grained sandstone, or Waverly series.

These strata are concealed beneath the superficial materials, which like a mantle have been spread over them, except where they are laid bare by the water courses, or emerge to the surface.

In describing the geology of this county, we will begin with the lowest rocks, and ascend in the series; they are,

1. Limestone;
2. Shale;
3. Fine-grained sandstone;
4. Superficial materials, consisting of clay, gravel, sand, boulders, marl, peat, and bog ore.

The following wood cut represents the manner of their occurrence and the unconformable position of the superficial materials. This cut is not perfectly accurate, but sufficiently so for illustration.



EXPLANATION.

A, Limestone;
B, Shale;
C, Sandstone, on the eastern line of the county;
D and E, Superficial materials;
b, b, b, Sandusky river, which is crossed three times by the above profile, extending from east to west through the county.
e, Broken Sword creek;
f, Tymochtee;
a, The position in which the bones of the mastodon were found by Mr. Hahn, near Bucyrus.

I. LIMESTONE.

A part, if not all of the limestone, which is seen at the surface in this county, is higher in the geological series than that found in Wood. In this county, also, the rock is variable in external character and mineral composition, at different localities. In some places, it is sandy and friable, easily quarried and dressed, while in others, it contains less impurities, being compact and tough, and yielding less readily to the implements of the artisan. It is generally destitute of fossils; at the falls of the Broken-sword, however, a few were observed.

The area occupied by this deposite, before it dips beneath the shale, is difficult to determine; yet, a line drawn from north to south, through the county, three or four miles west of Bucyrus, would not be far from its termination on the east; the part west of this line, comprising about two thirds of the area, is underlain by limestone, but generally covered with the superficial materials before mentioned.

Localities.—Nearly all the localities of limestone are along the beds or banks of water courses. On the Sandusky, it commences four or five miles below Upper Sandusky, and continues with partial interruptions, about the same distance above,—the whole distance being within the Wyandot Reservation. Below Upper Sandusky, the rock has been quarried in several places, for burning quick lime, and for building materials. At the quarries which I examined, it comes out in slabs from one inch to about one foot in thickness. The stone is light blue, sometimes dove colored; and occasionally, so free from impurities, that it will take a polish. The stone Church at the missionary station, is built of materials taken from a quarry about a mile below Upper Sandusky. Some fine slabs have, also, been taken from a quarry a mile or two below this place. At the Wyandot flouring mill, still further down the river, the rock appears in the bed of the stream; and has been excavated in digging a mill race. Here, it is somewhat different in its character, and interleaved with thin laminæ of shale. Above Upper Sandusky, the limestone appears in the bank of the river for four or five miles. It has been quarried by the Indians, at several localities. but in general, these quarries are not so good nor so numerous as those below the town—the rock being sometimes thinly laminated, or traversed by fissures, so that it is only fit for manufacturing lime.

These localities of limestone are the only ones known on the Wyandot Reservation; and are, therefore, of great value in this champaign country, where there is a scarcity of building materials.

Limestone of Sycamore creek.—All the localities observed on this creek, are in Sycamore township. Mr. Caldwell of Bucyrus, however, informed me, that he has seen the limestone, in situ, in the bed of the stream as far east as Lykins township, R. 16. Tp. 1. The limestone on this creek differs essentially from that last described; and is, probably, above it in position. That on the Sandusky is of a bluish color, compact and sometimes thinly laminated; while that on the Sycamore is light colored, sandy and seldom fissile. Such is the general char-

acter of the rock, where it was observed on sections 25, 26 and 27. It is not often elevated above the bed of the stream; but is so situated, that quarries may be opened in sufficient numbers to supply all demands in the vicinity.

Limestone of the Tymochtee.—All the localities of limestone which have been observed on this river, are between section 18, Tymochtee township, and section 34, Crawford township. It generally comes out in layers from one half an inch to nearly a foot in thickness, which are sometimes separated by thin leaves of argillaceous matter.—Slabs can be obtained of suitable dimensions for tomb stones, door sills, window caps and flagging stones, for which they are well adapted. The only places where quarries have been opened on this stream, are near Judge Carey's, in Crawford township, to whom I am indebted for much local information. In the N. W. corner of Crawford township, are two limestone ridges, where the rock can be obtained in almost any place, a few feet beneath the surface. These ridges, it is believed, are the only places where the rock emerges to the surface, distant from the water courses. It differs, in some respects, from the limestone on Sycamore, but like that, it is light colored and sandy; forming a sandy soil. No valuable quarries have been opened, but they probably will be found by the necessary explorations. These ridges occupy portions of sections 3, 4, 5, 6, 7, 8, 9, and 10.

Limestone of Broken Sword creek.—The limestone along this creek is generally so low, that it is often overflowed when the water is high. The only localities where it was examined, are on sections 25, 26 and 19. On the latter section are the falls of Broken Sword, the highest point on that stream which was explored. They are hardly worthy of the name of falls, being merely rapids in the stream, formed by the water falling over a few thin layers of limestone. It is grey, subcrystalline and contains a few fossils—the only ones observed in this county. Good building materials, and perhaps some sufficiently fine for ornamental work, can be obtained here at a low stage of the water. The superior part of the stratum is 10 or 15 feet above the bed of the river, and the layers are so thin as to render it of little value as a material for construction. Below the falls the rock assumes a more sandy texture, and is similar to that on Sycamore creek. It is traversed by fissures in various directions. The limestone of this county is little used, but is daily becoming an article of great economical value for building and agricultural purposes. It therefore becomes important to ascertain at what depth it can be reached by sinking shafts through the superficial materials, between the water courses. The above are the only places, with one or two exceptions, where, at this time, it can be obtained.

II. SHALE STRATUM.

This rock, so far as my observation extends, is disclosed only in one place in the county; this is in the bed of the Sandusky river, near the eastern line of the county, on sec. 27, Tp. 17, R. 21. It is thinly

laminated, dark colored, and sufficiently bituminous to burn with a flame when ignited. It is not sufficiently exposed to ascertain the dip and direction. It probably occupies an area equal to one-fourth of the county; and its western termination may be a few miles west of Bucyrus, at which place it has been penetrated at a depth of 30 or 40 feet, in boring for water. The shale above described is a part of the formation which extends from the Ohio river to Lake Erie. As it strongly resembles that which is found in connexion with the coal in the eastern part of the State, it has been often mistaken for an indication of that mineral. There is no probability, however, that valuable beds of coal will ever be found in connexion with this stratum. Yet in almost every county where this shale exists, it has been believed to be so sure an indication of coal, that much money and labor have been expended in fruitless explorations. Hence the great importance of ascertaining the *absence of minerals*, in order to prevent useless expenditures of time and money in searching for them, where there is no probability of success.

III. FINE-GRAINED SANDSTONE.

This rock is imposed on the shale, in the extreme eastern part of the county near the Richland line. The precise line of junction as well as the dip, could not be ascertained. This sandstone is fine-grained and micaceous; and suitable slabs for architectural purposes can be obtained. It is not so beautiful, however, as that obtained in the Scioto valley at Waverly, Piketon, &c. The only localities where this rock was observed, are on sections 35 and 36, in Sandusky Tp. On the east bank of the Sandusky river, (sec. 36,) it has been quarried, and used at Bucyrus and Marion. The material is rather beautiful and not affected by atmospheric agents. From this quarry grindstones of a pretty good quality may be obtained. Many other quarries, equally good, north and south of this, may be opened whenever the wants of the community require.

IV. SUPERFICIAL MATERIALS.

Under this head will be described all the materials found above, and reposing on the rocky strata before described. This arrangement has been adopted merely for convenience, as it is injudicious, to say the least, to attempt a classification where there is a probability that our views will be changed by subsequent examinations. I shall therefore merely record the facts observed, without attempting to draw conclusions, until further developments shall have been made.

By reference to the preceding wood cut, it will be seen that these materials repose unconformably on the subjacent strata.

1. *Bluish clayey stratum—reposing on the shale and limestone—represented by the letter D.* It is generally dark blue—effervesces with acids, and contains pebbles of primitive rocks and of the subjacent shale and water-worn limestone. Wherever examined, it seems to be desti-

tute of organic remains. This stratum appears to be co-extensive with the county, as it has been found in almost every section, in excavating wells and cellars. No opportunity has occurred to ascertain its relative thickness. It probably varies from 10 to 200 feet.

Economical uses.—It may be profitably used for agricultural purposes, as it contains considerable carbonate of lime. The super-stratum is often deficient in this principle.

2. *Yellowish clayey stratum.* This reposes on the one last described, and is represented on the wood cut by the letter E. This forms the surface of the country, and like the preceding stratum sometimes contains pebbles of primitive and secondary rocks. It is spread over the sub-jacent layer in an undulating manner, accommodating itself to the elevations and depressions of the surface. This stratum, intermixed with vegetable matter, forms the soil of the county. Thickness from 5 to 10 feet.

Economical uses.—It may be used in the manufacture of brick. Care should be observed, however, in selecting the clay, which should be as free as possible from calcareous particles. It is also used in the manufacture of earthen ware.

BOULDERS.

Boulders of gneiss, granite, hornblende, &c. are scattered over the surface of this county. They are generally small, but some of them will weigh several tons; and from their hardness are denominated "nigger heads" or "hard heads." They appear to have been rounded by attrition, or atmospheric agents.

PEAT.

In my explorations in this county, I have been successful in finding several beds of this valuable material. The most extensive is found in the northeast part of the county, in Cranberry township, in a wet prairie called Cranberry marsh, which, as indicated on the map, embraces nearly 2,000 acres. The surface is covered with a growth of sphagnous moss, prairie grass, and cranberry vines, which cover the semi-fluid matter. This marsh is on elevated ground, and forms the source of several streams: it is probably the bed of a pond partly filled with argillaceous deposits, while the peat is the result of successive accumulations of vegetable matter; it is spongy, and the vegetable matter is not sufficiently decomposed to render it the most valuable for fuel. Its average thickness is about 6 feet. I am informed, however, by Mr. Heitich, that in many places it is 12 feet. The quantity of peat in this marsh may be estimated at 2,500,000 cords.

Another marsh occurs in the northeast part of the county, partly on section 36, township 18, and on section 1, township 17, which contains, by estimation, 200,000 cords. It is more compact, and darker colored than that last described.

Another marsh occurs on sections 5, 8, 9, 16, and 17, township 1, range 17, containing at least 1,000,000 cords.

On the Wyandot reservation are several peat marshes, containing, probably, 600,000 cords.

On the lands of Mr. Hahn and Judge Failer, near Bucyrus, are found some small beds containing, probably, 10,000 cords: other beds will, doubtless, be discovered and brought into use when their value for fuel, agricultural and other purposes, shall have become fully appreciated.

FRESH-WATER-SHELL MARL.

This is formed by the accumulation of fresh-water shells mixed with variable proportions of argillaceous matter. It is usually formed in ponds or marshes which, in some cases, have been subsequently covered by a growth of forest trees. Those waters which are most highly charged with carbonate of lime—from which the molluscous animals construct their shells—are most favorable to its production. It can be detected by applying acid, which is attended with the escape of small bubbles of gas. In Crawford county, it has been found only in one or two places. Near Bucyrus, on the land of Mr. A. Hahn, a bed, three or four feet thick, was discovered in excavating a mill race. It is made up of an accumulation of shells, in which I observed lymnea, planorbis, physa, and species of the genus cyclas. There is more or less clayey matter intermixed. This bed will be valuable as a mineral manure.

Another bed is found on the land of Judge Failer. Near Mr. Armstrong's, on the Wyandot reservation, I discovered a bed several acres in extent, and four or five feet in thickness: it is below a bed of peat, so that it was only examined by the instrument before described. These are the only localities which, as yet, have been discovered in this county; but there is little doubt that other beds will be brought to light.

The peat and marl, above described, are found in depressions formed by erosions or undulations of the surface; and are, therefore, more recent than the *yellowish clayey stratum* represented on the wood-cut by the letter E.

BOG IRON ORE.

Bog-iron ore may be regarded as alluvium, as it is now forming in many places. It is deposited from the surface waters and springs, in which it is held in solution, by means of carbonic acid. As the excess of acid escapes, the iron is deposited, generally in the form of a yellowish or orange-colored sediment. The principal sources from which the ferruginous matter is derived, are from yellowish and reddish soils, which always contain iron, and from the decomposition of pyrites, which in some of our rock formations—particularly the shale—occurs in great abundance.

A few deposites formed in this way were observed in this county.

It is not improbable that quantities may be found sufficient to justify the erection of iron works. As this region, however, is destitute of coal, and a portion made up of open prairie, the scarcity of fuel would be a serious drawback to such an undertaking.

Localities.—Bog-ore occurs on the land of Peter Long, southwest quarter of section 3, Sandusky township. Here it is intermixed with sand and pebbles; but portions of it are sufficiently free from these ingredients to answer for smelting. This bed occurs at the outlet of a kind of marsh known as a "cat swamp." It has been quarried and used for the back walls of chimneys. I had no means of ascertaining its extent.

On the northwest quarter of the same section, according to Mr. Long, another bed, presenting similar characteristics, is found.

On the left bank of the Sandusky, about one mile southeast of McCutchensville, bog-ore is found of a good quality: specimens were procured from masses weighing two or three hundred weight. There are several other localities in this vicinity.

On the southeast part of the Indian reservation, on the land of Charles Garret, bog ore was found under a bed of peat: it is of a good quality, and about one foot thick, occupying, apparently, an area of several acres. It is also found in the townships of Sycamore, Lykins, and Chatfield. From these indications, we think that sufficient ore might be found to supply furnaces.

Calcareous Tufa.

This is deposited from water holding carbonate of lime in solution by means of carbonic acid. The excess of the latter escapes while the former is deposited, in the form of an impure, porous carbonate of lime, known by the name of tufa or travertin. Sticks, leaves, &c., are often incrusted with this substance.

Two localities of this tufa have been observed: the first is near Bucyrus, on the left bank of the river. Large masses of this material lie on the surface, and contain shells of the genus helix. It is too porous and friable for a building material, but may be advantageously used for burning into quick lime, which is now brought to Bucyrus from a distance. The second is on the southeast corner of the Wyandot reservation. It is found in loose blocks on the surface. Whether it can be found in sufficient quantity to be valuable, is uncertain.

Mineral Springs.

Among the most interesting objects of investigation in this county, are the mineral springs, some of which will, doubtless, prove valuable for their medicinal properties.

Sulphur Springs, or those which contain sulphuretted hydrogen gas, may be detected by immersing silver in them, which soon becomes tarnished. These springs often contain saline ingredients in various proportions.

Carey's Spring issues from a ledge of limestone 15 or 20 feet above

the bed of the Tymochtee. Though not copious, it is never known to fail. The water is highly charged with sulphuretted hydrogen, and some saline matter. It operates as a gentle cathartic upon those not accustomed to its use.

Wyandot Sulphur Springs.—These are about two miles below Upper Sandusky, on the left bank of the river of the same name. The first issues from a bed of limestone a few feet above the river, and discharges perhaps a gallon per minute. It was in the dryest part of the season when I visited it, and the springs in the vicinity were lower than they had been known for years.

The larger spring rises from an alluvial tract, a hundred yards from the river: it is copious, forming a pool several yards in diameter. Both of these springs are highly charged with sulphuretted hydrogen, and deposite sulphurous precipitates. From the latter spring, water was procured for analysis. Both of these springs have been slightly examined by Dr. Riddell, who detected in them, by re-agents, the following ingredients, viz: sulphuretted hydrogen, sulphuric and muriatic acids, lime and magnesia. He further remarks:

"These waters unquestionably possess remedial virtues of a high order; but, unfortunately, the site is subject to the sweeping inundations of the Sandusky, on which account, not even the rudest accommodations have yet been attempted."

Annapolis Sulphur Spring, is one of the largest and most beautiful with which I am acquainted. It is owned by Mr. Sliffer, who has caused it to be walled and enclosed with an iron railing. It forms a clear limpid pool about five feet square, and discharges, as nearly as could be judged by the eye, four or five gallons per minute. Bubbles of gas, probably sulphuretted hydrogen, occasionally rise to the surface. Silver coin immersed in the water, becomes rapidly tarnished. This spring, doubtless, possesses remedial virtues; but I could not learn that it had been used in the cure of diseases. Water was collected for analysis.

Knisley's, or Crawford Sulphur Spring.—This, though not so copious as that at Annapolis, discharging, by estimation, about one gallon per minute, is, perhaps, deserving of more particular notice. The location is about 7 miles northeast of Bucyrus, on section 26, Sandusky township. It is not far from the Sandusky river, but so elevated as to be above the reach of high water. The water is highly impregnated with sulphuretted hydrogen, tarnishes silver, and deposites a sulphurous precipitate a short distance from the spring. One of its most remarkable features is a deposite of a reddish or purple sediment at the bottom, giving to the water a color resembling a tincture of iodine. What the coloring matter of this precipitate is, no experiments have been instituted to ascertain. The water contains sufficient saline matter to operate as a gentle cathartic, when taken in moderate quantities; and is also diuretic and diaphoretic in its effects. A portion of this water was collected for analysis: it was not tested by re-agents; but, from evaporation, a brownish yellow substance, probably sulphates of magnesia and lime, was obtained in considerable

quantities. Several invalids have been at this spring during the past season, as I am informed, with decided benefit to their health. When the necessary arrangements shall have been made, this place may be one of our most valuable watering places.

Gas Spring.—A few rods from the spring just mentioned, is another from which carburetted hydrogen gas issues in such quantities as to burn with a constant flame when confined and permitted to escape through a small tube. This, as a natural curiosity, may be interesting to visiters. The gas is produced by chemical action in the sub-jacent stratum of shale, from which this spring undoubtedly rises.

Chalybeate Springs.—The water, in several places, deposites ferruginous matter; but the only chalybeate springs which I observed are in a ravine on the opposite side of the river from Bucyrus. The water contains some iron, which forms a yellowish precipitate. This water may be used as a tonic in some cases of debility. It may here be remarked, that the water which supplies wells, springs, &c., almost always contains more or less carbonate of lime in solution.

BONES OF THE MASTODON.

Part of a skeleton of the mastodon was found while excavating a mill race, in the vicinity of Bucyrus, during the past season. The race to which this animal belonged, has long since disappeared from the face of the earth, and everything which can throw light upon the causes of its extinction, and the time of its disappearance, is matter of the highest scientific interest. All facts, therefore, in relation to this subject should be faithfully recorded. A detailed account of this skeleton would have been drawn up for this report; but want of time and other circumstances render it impracticable; therefore, a catalogue and a brief description of the bones, and the situation in which they were found, will only be given. The following are the portions of the skeleton found by Mr. Hahn:

HEAD. The entire head, with the exception of the tusks.

VERTEBRÆ. 6 Cervical.
" 6 Dorsal.
" 1 Lumbar.
" 5 Caudal.
RIBS. 28. 12 entire.

PELVIS. The sacrum and the whole of the left side, and the os pubis, and part of the os ischium of the right side.

EXTREMITIES. 1 Femoris.
1 Tibia.
1 Fibula.
1 Radius.
1 Ulna.
2 Patellæ.
11 Bones of the feet.

These bones, though not so large as the corresponding ones of the skeleton in Peale's museum, were probably those of an old animal, as ossification had taken place between some of the vertebræ, while some of the sutures between the bones of the head were nearly obliterated.

Head.—The zygomatic processes of the malar and temporal bones were broken from the skull in removing it from the earth: these pieces, however, can be re-united; and, with this exception, the skull is entire. It seems to have undergone little change; and even the superior portions, which are so liable to decay, are most perfectly preserved. In this head, the most striking peculiarities of the mastodon are recognized: as the form of the teeth, their divergence in front, the extension of the palate behind the molars, the great size of the pterygoid apophysis of the palate bones, and the situation of the orbit of the eye, with other particulars which need not now be mentioned. The skull weighed, when taken from the earth, 180 lbs. As a full description is not intended at this time, a few of the measurements only will be given. The greatest breadth of the head, formed by the occipital bone, is 24½ inches, and this bone extends nearly to the superior part of the head, a slight curve only being formed above it. This bone, which is 17½ inches in height, is very rough and uneven, presenting a proper surface for the insertion of large and powerful muscles necessary to support the enormous head of the animal. The distance from the base of the occipital bone, over the superior part of the head to the termination of the intermaxillary bones, is 57½ inches. The distance across the superior part of the head, between the temporal fossæ, is 15 3-8th inches; while the greatest breadth of the head, formed by the zygomatic arches, is 27¼ inches. Thus large spaces are left within the temporal fossæ to be occupied by powerful muscles. The distance between the orbitory processes, over the anterior part of the head, is 22 inches. The interior diameter of the tusk sockets is 5½ inches.

The under jaw weighed, when taken from the earth, 69 lbs.: its length is 2 feet, 6¼ inches; and the distance from the top of the condyloid process to the angle of the jaw, is 12½ inches; while the articulating surface of this process is 5½ inches.

Teeth.—There are only two teeth in either jaw, the front molars having been shed, and the spaces which they occupied are nearly closed. When taken from the earth, however, one of the front molars of the lower jaw remained slightly attached by the roots, which were nearly absorbed. The teeth of the upper jaw are 6¾ inches long, and 3½ inches wide; the lower are 7½ inches in length, by 4 inches in breadth.

Vertebræ.—The first vertebra of the neck, for the reception of the occipital condyles is 14½ inches in length, by 9.8 in breadth. The spinous processes of the dorsal vertebræ are from 15 to 16 inches in length; and the transverse diameter, including the transverse processes, is from 11 to 12½ inches. The whole length of the dorsal vertebræ, including the spinous processes, is from 19 to 21 inches.

Ribs.—The longest measures 54 inches on the outer curve. Only 12 perfect ribs were found; the rest were somewhat decayed.

Humerus.—This is the upper bone of the fore leg: it is a massive bone 30¼ inches in length; its greatest circumference is 33 inches—smallest, 14 3-8th inches.

Ulna.—This is the largest bone of the lower part of the fore leg.

Length, measuring the olecranon process,	25¼ inches.
Circumference around the elbow,	35 "

Radius.—Smallest bone of the fore leg—length	23 3-8th in.
Circumference in the centre of the shaft,	6¼ inches.
Breadth of the carpal or articulating surface,	4¼ inches.

Pelvis.—The left side was broken in removal, but I was able to replace the broken fragments, so that, with some pieces of the right side, I was enabled to make pretty accurate measurements of the pelvis. They are as follows:

Width, measuring from the anterior superior spine of the ilium to the symphysis of the pubis,	2 feet, 2¼ inches.
Distance from the symphysis of the pubis to the sacrum,	17 "
Transversely from the linnea innominata, on the margin of the pelvis, to the corresponding place on the opposite side,	20 "
Diameter of the acetabulum or socket, for the reception of the head of the thigh bone,	6¼ "

Femur, or thigh bone.—Length,	36¼ "
Circumference at the middle of the shaft,	16 "
Greatest diameter at the same place,	6 3-8th in.

Tibia and fibula, (lower part of the hind leg.)

Tibia, length,	22 inches.
Breadth of superior part,	8¼ inches.
Breadth of inferior part,	7¼ inches.
Diameter in the middle part of the bone,	3 3-8th in.
Fibula, (a slender bone,) length, passing 3 inches below the tibia, to form a part of the foot.	20¼ inches,

The bones above described were found near the dividing ridge between the waters of the St. Lawrence and the Gulf of Mexico, in a bed of fresh-water-shell marl, about 4 feet in thickness. The marl is composed of argillaceous matter and fresh-water shells, among which were observed lymnæa, physa, and planorbis; and is covered by a layer of peat 4 feet thick. These beds were deposited in a depression formed by an undulation or erosion in the yellowish clayey stratum before described, and are, therefore, more recent than that deposite; but contemporaneous with the beds of peat and marl with which the western part of the State is known to abound. Their geological position is indicated on the preceding wood-cut by the letter *a*. The mastodon, then, has become extinct since the deposite of the materials upon the surface of which are our magnificent forests and beautiful prairies.

HOCKING AND ATHENS COUNTIES.*

The geological position of these counties is indicated on the vertical section, as extending from the superior part of the fine-grained sandstone upwards, so as to embrace the "calcareo-silicious rock," and some hundreds of feet of the *coal measures* above that deposit. The surface of the country is uneven, rising into irregular elevations from 300 to 400 feet above the water courses, which, in times past, appear to have worn their way through the strata, so as to give to the surface, once a plain, the features which we now observe. The hills have rounded outlines, but sharp declivities. The principal streams are the Hocking and its tributaries, and Salt creek, a branch of the Scioto, which sweeps through the western part of Hocking county.

It should be here remarked, that these counties present so many interesting subjects to the geologist, in an economical and scientific view, that months, instead of a few weeks, might be profitably spent in their examination. As it is, it should not *by any means* be supposed that valuable discoveries will not, hereafter, be made; but on the contrary, that the present examinations, although as minute as time would permit, will only serve as a guide, or incitement to future developments.

The rocks will be described in the order of superposition, beginning with the lowest and ascending in the series.

III. FINE-GRAINED SANDSTONE.

This is indicated on the vertical section, by these numerals (III.) The superior part of this stratum appears along the water courses in the west and southwest part of Hocking, forming the lowest rock seen in situ, and the one upon which are imposed the strata hereafter to be described. Its external character and mineral composition have already been given, and need not now be repeated.

The *fine-grained sandstone* is well developed along the bases of the hills on Salt creek, in the township of that name; and through the whole distance affords good materials for various purposes—as for coarse masonry, flag-stones, grind-stones, and architectural work of an ornamental kind. Situated as they are at this time, the demand will be limited; but it will increase as the country becomes more densely populated. It is desirable that public attention be directed to the most valuable localities.

The valley of the creek before mentioned, is very narrow, and the sandstone rising in bold escarpments, capped by the conglomerate, forms elevations three hundred feet or more, in height. The steep declivities of these hills, are often covered with a beautiful growth of evergreens; while along their bases, the stream wanders from side to

* In the examination of a part of these counties, much valuable assistance was derived from some geological notes, in manuscript, furnished by Dr. Hildreth. This gentleman has done more towards directing public attention to the geological structure and mineral wealth of the State, than any other individual; and the benefits which he has thus conferred, can never be fully appreciated.

side of the valley, pursuing its solitary way among scenery rarely equaled in Ohio, for wildness and beauty.

IV. CONGLOMERATE.

This stratum reposes conformably on the preceding, as indicated on the section by the prefixed numerals. The thickness probably varies from 200 to 300 feet. It is made up of several layers, variable in character, even in short distances. In some places, it is an aggregation of quartzose pebbles and silicious sand; while in others, there are few if any pebbles, the rock assuming the character of sandstone. It is generally light colored, but in some places, is tinged red, with the oxide of iron. This stratum occupies the western part of Hocking county. Towards the east it gradually dips till it sinks beneath the incumbent rocks, while westward towards the lines of Pickaway and Fairfield, it forms outliers, and caps the highest elevations. It is found in Salt-creek, Jackson, Benton, Laurel, Good Hope, Falls and Marion townships; near Logan, it disappears beneath the bed of the Hocking. The region traversed by this formation contains the most beautiful and picturesque scenery in Ohio; and is no where more strikingly so, than along the waters of Queer creek, in the township of Benton. Here the waters have worn their way through the rocks, leaving mural escarpments, crowned by oaks and sometimes by evergreens. The stream winds through this wild and rugged region, here washing the base of a beetling precipice, there slumbering quietly in its channel, and anon dashing over a precipice in a beautiful cascade. The most interesting fall is on section 13, Benton township. A short distance above, the water runs in a narrow, devious channel, cut in the solid rock, as though collecting its strength for a leap over the precipitous ledge which forms the falls. Their whole height, embracing some minor descents, is 87 feet,—the principal one being 64 feet over a perpendicular ledge.

The falls of Hocking and Scott's creek are formed by this stratum; but they are not of sufficient interest to render them worthy of particular description. The *former* is a rapid descent of the river over a rocky channel, sufficient only to make it a valuable site for manufacturing purposes; while the *latter* is a fall of seven or eight feet over the perpendicular rock.

Economical uses.—From this stratum are obtained excellent building materials, and in such abundance as to be inexhaustible. Those quarries, however, which are situated along the valley of the Hocking, will be the most valuable, as the stone can be easily transported to any point along the line of the canal. This rock has already been quarried at several points between Logan, and the western part of the county, and at many intermediate places, as far as Lancaster. Large quantities of the stone have been wrought at these places for locks and culverts on the canal, now constructing. Particular points where quarries may be opened, need not now be mentioned. None of the stone, however, where it disintegrates and crumbles, should be used;

and, therefore, in the selection of quarries, the material should be examined in situations where it has long been exposed to the weather. Some of this stratum, being destitute of the oxide of iron and aluminous matter, may be advantageously used for the manufacture of glass.

It may here be proper to state, that some of the sandstones which are peculiarly liable to disintegration, may be preserved by covering them with a coat of paint, or by oiling them. In this way, water may be exlcuded, which insinuating itself between the particles of the stone, and expanding by the action of frost, would cause it to crumble. A coat of paint would, in the same way, protect those varieties of the fine-grained sandstone, which are peculiarly liable to decay from the decomposition of iron pyrites. But after quarrying, the moisture should be permitted to escape before the application of paint. Perhaps some of the porous or friable varieties of rock may, also, be rendered durable by applying boiled plaster, or water cement, so as to fill up the interstices between the particles, thus rendering them proof against atmospheric agencies. It is hoped that these suggestions may be valuable to those who have used materials without the proper care in the selection.

V. COAL MEASURES.

This division embraces all the strata in the State above the Conglomerate. It consists of alternations of sandstones, limestones, shales, coal and iron ores, together with the "calcareo-silicious rock." They lie conformably upon the subjacent strata, and dip gently to the E. S. E. These alternations, as represented on the vertical section, (No. V), were not designed to be strictly accurate; but are merely for the purposes of illustration, for which they are sufficiently correct.

The strata of the coal measures will be described under the following subdivisions:

1. Sandstones.
2. Limestones.
3. Buhr or "calcareo-silicious rock."
4. Shales.
5. Coal.
6. Iron ores.

1. Sandstones.

Rocks of this character greatly predominate in the coal measures. They are composed mostly, of silicious sand, often intermixed with mica and argillaceous matter; and sometimes contain feldspar in a state of decomposition. They are generally light colored, but often variously tinged with oxide of iron, which is so abundant in many cases, as to change them to a deep red on the application of heat. This effect is produced by the peroxidation of the iron which they contain.

Their economical value has not hitherto been appreciated. They are applicable to a great variety of useful purposes:—as the manufacture of glass, tombstones, grindstones, the construction of furnaces, locks, culverts, and are, also, valuable for some kinds of ornamental work. Many of them endure, unchanged, the vicissitudes of the weather, and are little affected by heat sufficiently intense to calcine marble, and break in fragments the best kinds of granite. Some of them are equal in beauty, to the best granites of the Atlantic; and, as they are less affected by heat, will be more valuable as building materials, particularly in cities, where edifices of the latter are often destroyed by fires, which would little injure those constructed of the former. It is not too much to say that the sandstones of Ohio will be, to our rising and future cities, what the durable and beautiful granites of New England are to our large eastern towns.

As quarries from which good materials for construction can be obtained, are found in every township, and on almost every section in these two counties, it is needless to specify localities, except on the Hocking, where they will hereafter be of value for transportation to distant places.

A fine-grained sandstone, and rather a handsome material, is obtained about one half of a mile below Logan, on Sec. 12, R. 17, T. 14. It was exposed by the excavation for the canal, but whether it is distinct from the conglomerate, or forms a part of that stratum, is doubtful. This quarry is well known, but others equally as good can doubtless be opened, not only along the valley, but distant from it, north and south. This quarry contains the remains of some radiated and molluscous animals.

Another quarry, above the preceding in geological position, has been opened about 3½ miles below Logan—80 or 90 feet above the Hocking. It is fine-grained and micaceous,—the mica forming the lines of cleavage, and in some places, giving to the rock a laminated structure. Slabs of suitable size for various purposes of construction can be obtained. Some of them are nearly equal in beauty to the Waverly stone, and though rather coarser in texture, may be used for the same purposes. From this quarry good flag-stones and tolerable materials for grind-stones may be obtained. Here was observed in the solid rock, particles of bituminous coal, with fragments of the vegetable remains of which they were formed. This may be an interesting fact to those who deny the vegetable origin of our fossil fuel.

A quarry has also been opened in this stratum on the river, near the line of Hocking and Athens. Here has been quarried some of the most beautiful sandstone I have ever seen. Some of the slabs are so white that, at a little distance, they might be mistaken for primitive marble. This rock will no doubt furnish, for the canal and other public works, materials of good quality and in great abundance.

The limits of the present report will not permit us to mention, far less to describe, all the localities of sandstone throughout the valley, whence good materials for construction can be obtained. But below

this point, as far as Nelsonsville, in Athens county, sandstones have been quarried for the construction of locks, culverts, etc. on the canal; and further down the river there will probably be no difficulty in obtaining materials. They have also been quarried at Athens. Between that place and the mouth of Hocking, are sandstones of a good quality, which will be valuable when the canal shall be extended in that direction. One stratum was traced from a little below Federal Creek to the Ohio river, a distance of nine miles, forming mural escarpments along the Hocking valley. In a southeast direction it dips about 14 feet per mile. It is somewhat variable in color and mineral composition at different localities. In some places it contains pebbles, and were it not for its geological position, might be mistaken for the conglomerate; in others, the materials are much finer, and often arranged in a slaty structure. This stratum is fifty or sixty feet in thickness.

I would here remark, that gréater care is necessary in selecting sandstones for locks and piers, than for most other purposes; for in such works they are subjected not only to the severest tests from atmospheric agents, but are also exposed to the abrading action of water and of heavy bodies forced against them. And I am informed by Mr. Price, one of the Canal Commissioners, that it is feared some of the stones which must be used in the contruction of locks below Logan, will not be very durable, though very valuable for the ordinary purposes of construction. This, he thinks, will be the case with those which contain feldspathic sand undergoing decomposition on exposure to the atmosphere.

Hone or whetstones. There are some pretty good materials among the sandstones for hone and whetstones. There is a locality of very fine silicious rock on the land of Mr. G. Cook, section 19, Rome township, which is well adapted to the above uses. Mr. C. who has manufactured a few the present season, informed me that they are highly approved, and presented me with some of the specimens for the State cabinet.

On section 19, Vinton township, the shale below the coal passes into a very fine-grained argillaceous sandstone, which is manufactured by Mr. Ratcliffe into hones, or oil-stones, for which he says it is well adapted. This stone falls to pieces on exposure to the weather, but can be rendred durable by saturating it with oil. It appears to be abundant, and doubtless will be valuable for the purposes just enumerated

Stones have been obtained for similar purposes near Athens, but it is doubtful whether the rock will prove of much value.

Monday creek hones.—The hone stone quarry on Monday creek, although it may possibly be a part of the "calcareo-silicious rock," may be mentioned in this place. This quarry is in Hocking Co., R. 16, T. 14, Sec. 26. The stone is composed of very finely divided particles of silicious matter, often white and sometimes tinged with shades of yellow, and contains irregular masses or veins of hornstone. Hones of an excellent quality were manufactured from portions of this rock, and sold in New York, where they have been purchased by our mer-

chants and brought again to Ohio for sale. The reputation of the quarries, I understand, was injured by supplying the market with an inferior article; but the quarries were finally abandoned under the idea that the best materials had been exhausted. This, however, I am confident is not the fact, as there is little doubt that the quarries may be successfully re-opened and others found, by tracing the deposit in the vicinity, and opening it where there are facilities for mining.

2. LIMESTONES.

There are several distinct layers of limestone, interstratified with the rocks of the coal measures. These strata, though not now appreciated, will hereafter prove of great economical value. They will furnish materials for lime, building stones, McAdam roads, marbles, and fluxes for iron ores. Of still greater value will they be for agricultural purposes, situated as they are, among strata which contain little carbonate of lime. Of their applicability as a fertilizer, we shall have occasion hereafter to speak.

The lowest stratum of limestone which was observed, is in Hocking county, on Three Mile run, Sec. 28, Green township, a little more than a mile from the Hocking river, and about three miles below Logan. It lies in layers from a few inches to a foot in thickness; the average depth of the stratum being from 8 to 9 feet. The upper portion, from 3 to 4 feet in thickness, is yellowish or buff colored, containing so much iron that it may perhaps be used as an iron ore. At any rate, the ferruginous matter will render it the more valuable for a flux. The lower layer is nearly white, and will make lime of a superior quality. It seems to be nearly pure carbonate of lime; and in places, sub-crystalline, and sufficiently compact to admit of a polish. Specimens were collected with a view of ascertaining their value in this respect.

North of the above locality, this limestone deposit can be found in numerous places, although the out-cropping edges are now concealed by the superficial materials. It was observed in two or three places on Sec. 30, T. 14, R. 16. It can be seen to the best advantage in the southeast part of Perry county, at McCormick's quarry, on Sec. 17, in the township before mentioned. Here it is extensively quarried for the manufacture of lime. A new quarry has also been opened south of it on Sec. 20. This stratum affords a good stone for McAdamizing roads, for which purpose, I believe, it has been used where it approaches the National road.

South of the Hocking river I have not been able to trace this deposit unless it passes into a sandy micaceous limestone, which is probable, from the fact that both varieties occupy nearly the same geological position. But still they may be distinct deposits, occupying different positions in the geological column. The sandy variety was seen in Swan and Jackson townships, Hocking county, and in Elk township, Athens county, section 8, where it occurs above a valuable bed of coal.

The geological position of the next bed, is perhaps a hundred feet above the preceding. It is dark colored, and contains numerous organic remains of molluscous and radiated animals. In Hocking county, small fragments from this stratum were first observed on the summits of some of the highest elevations near Logan; subsequently it was found, in situ, on section 30, T. 12, R. 16. Judging from the masses lying on the surface at this locality, the bed may be 5 or 6 feet in thickness. This stone will bear a polish, and it doubtless may be obtained in slabs of suitable size for ornamental architecture. Passing southward to the head waters of Raccoon, this stratum again appears along that stream in the neighborhood of Judge Wright, of Star township. It also appears at the surface on the road from McArthurstown to Chillicothe, two or three miles from the former place. Should this rock prove valuable as a marble, further explorations will be made by those personally interested; and new localities will be developed.

At Nelsonville, above the coal, are two beds of limestone, chiefly valuable for the manufacture of quick-lime, for which they have both been used. The beds are thin, and the upper fossiliferous and sometimes tinged with iron. These beds may be opened both north and south of this place; and they are also disclosed in many places in the western part of Athens county.

Between Nelsonville and Athens, beds of limerock occur at various places, but as the localities are well known they need not be enumerated.

A stratum of limestone above those previously described, occurs on the Hocking hills, 3 or 4 miles below Athens; and gradually dipping in an eastern direction, disappears beneath the bed of Federal creek, not far from its mouth. It is disclosed along the west line of Rome township, to the depth of 15 or 20 feet. It appears to be non-fossiliferous; is light colored, and calcines into lime of good quality. It comes out in slabs which can be used for various architectural purposes.

Another important layer of limestone, above the preceding, occurs along the sides of the hills below the mouth of Federal creek. It is interstratified with thin beds of shale, which, in some places, are calcareous; the whole attaining an aggregate thickness of 30 or 40 feet. The rock varies much in color where it has been observed, being yellowish, buff colored, grey or blue in different localities, or in different divisions of the stratum. By the most diligent search, not a trace of organic existence was observed. The thickness and continuity of this deposit, with other considerations, render it one of the most valuable in the coal measures. It will afford building materials; and has already been burned into lime and sent down the Ohio to a market. The economical value of this stratum will be greatly enhanced when the canal shall have been completed to the Ohio river. The above description of the limestone deposits is necessarily brief and imperfect; since to embrace all the facts, would swell this report to an undesirable extent.

3. BUHR OR "CALCAREO-SILICIOUS ROCK."

An interesting and detailed account of this valuable deposit, was given by Dr. Hildreth, in the first annual report. A few facts, therefore, can

only be given in addition to those already collected. In that report, the range, extent, thickness, external and chemical characters, and the economical value of this stratum, are fully set forth.

This stratum is quarried to some extent in the vicinity of McArthurstown, Athens county, and manufactured into mill stones which find a market in various parts of the western country, and are generally highly prized by those who use them. This stone has recently been manufactured into coffee mills, for which it seems well adapted. The amount received from the manufacture of the above articles, is between 20 and $30,000 per annum; and the time cannot be distant, when this branch of industry will be greatly extended. These quarries are the more valuable, as good materials for these purposes cannot, probably, be obtained far north of McArthurstown. For where the rock is occasionally seen in place, its character is so changed, that it is of little economical value, becoming, as it does, more calcareous, with seams of compact hornstone.

The point where it crosses the Hocking valley has not been ascertained, and I am inclined to believe that it sometimes passes into limestone, which cannot be identified except by geological position. Thus, it appears there is little prospect of finding good quarries in Hocking and Athens, north of McArthurstown. But others may be found in Elk, Brown and Vinton townships in Athens county, and in the northeast part of Jackson county.

4. SHALES.

Interstratified with the other rocks of the coal measures, are found numerous beds of argillaceous shales. Their prevailing colors are yellowish, reddish, grey or black; and in some places, the latter varieties contain so much bituminous matter as to burn freely when ignited. When found associated with the coal, they often contain beautiful impressions of extinct vegetables. These shales are farther interesting, as being almost invariably associated with beds of iron ore. Those which form the floor of the beds of coal very often disintegrate into clays which are valuable for fire brick and stone ware, though I am not aware that they have been used for these purposes. The shales are far more abundant *above* than *below* the buhr. Some of the beds are from 50 to 80 feet in thickness, and form, I am inclined to believe, the predominating rocks in the middle and eastern part of Athens county, where they cause an important change in the agricultural character of the region.

Some of the red and greenish, or olive colored shales, which occur along the valley of the Hocking, below the mouth of Federal creek, may perhaps, be valuable as lithic paints, where beauty is not required. The greenish variety, found along the side hills, on the south side of the valley, a little below Bebee's tavern, has, in one instance been used successfully for this purpose. Properly prepared and mixed with oil, it forms a durable, though not very beautiful pigment. Further trial with this and the red shales, it is believed, will introduce cheap and durable paints for ordinary purposes. These shales are found continuous over large areas in the eastern part of Athens county—being exposed along the ravines and water courses.

They are mostly impervious to water; and hence, where they occur, give rise to springs, which are more numerous on the eastern and southern declivities of the hills, as the strata dip to the east and south. These facts should be borne in mind in the construction of roads in the hilly portions of the State; for if the location be along a hill side at the out-crop of a shale stratum, supporting the water so as to form springs, the road will be wet and muddy; whereas, if it were located above the water-bearing stratum, it would be dry and require less expense for repairs. As the springs are not so abundant on the western and northern declivities, other things being equal, they should be chosen for locations in preference to the eastern and southern slopes. By attending to these suggestions, much money in repairs might be annually saved, while at the same time the facilities for traveling would be increased.

5. COAL.

In that part of the coal measures embraced in these two counties, there are at least ten or twelve beds of coal, varying in thickness from a few inches to 10 feet.

They are situated along the line of the canal, which, before many years, will communicate with the main canal on the one side, and the Ohio river on the other. They cannot, therefore, fail to become of immense value. These beds are interstratified with the rocks above described, and crop out at the surface, successively, as we travel from west to east. Their western termination may be represented by a line drawn from the centre of Jackson to Hocking county, to the middle or eastern part of Marion township. But on account of undulations, and perhaps dislocations of the strata, and the difference of elevations at various places, coal may sometimes be found *west* of this line, and be deficient in some localities *east* of it. The thickest and most valuable beds of coal, however, do not extend so far west as this line. Like the layers with which they are interstratified, they vary so much in thickness and external character, that it is difficult to identify them at remote points; and their identification is the more difficult as they are seldom exposed at the surface, being concealed by the loose materials except along the ravines and water courses.

The lowest workable bed was observed from 4 to 7 miles above Nelsonville, but the same stratum probably extends much farther up the Hocking; and from explorations which have been made during the past season, it is possible that coal, which is workable in other places, may be found on some of the highest elevations on the opposite side of the river from Logan. Here, scarcely any efforts have been made to ascertain the thickness, or even the existence of coal.

Mr. Brit penetrated a stratum from 3 to 4 feet in thickness in digging a well about 4 miles above Nelsonville. It does not, however, appear to be so thick in other places, and the average thickness of this bed, along the Hocking, may not be more than 2 feet. The coal is variable in character, and made up of thin laminæ, on which traces of vegetables may be distinctly seen. It was formerly wrought, principally for smith's purposes, in the bed of the Hocking, near Nelsonville. With this exception, I am not aware that this bed of coal has been used in the valley.

Nelsonville coal.—The next valuable bed of coal occurs about 80 or 90 feet above the preceding. As it has been most extensively wrought in the vicinity of Nelsonville, it has been called "Nelsonville coal." This bed is one of the most valuable in the State, not only on account of its superior quality and its proximity to the water courses; but, also, for the facilities with which it can be obtained. Above it, is a stratum of sandstone which, in most places, will form a permanent roof, when mines shall be opened. The coal is made up of laminar divisions so thin that several can be counted within the space of an inch; and between them, traces of vegetables can generally be observed. It contains some sulphuret of iron, but as it generally comes out in masses, and is not disseminated, the value of the coal is little impaired. The average thickness of this bed may be rated at 6 feet, but it varies from 5 to 9. As we descend the river from Nelsonville it gradually dips and finally disappears below the bed of the Hocking, about five miles below the former place, on section 8, township 12, range 15. Taking into account the fall of the river, the dip between the two places will be between 20 and 25 feet per mile, in a south or southeast direction. West of Nelsonville, it extends up the river, gradually becoming more elevated till it runs out on the tops of the hills, three or four miles above that place. North of the river it can be found on almost every section in the township of Ward and the western part of Trimble; and is well disclosed in many places along the branches of Monday creek. On the Snow fork of that stream, the stratum is more continuously exposed than in most other places where it has been examined. It lies but a few feet above the water, so that the debris, which often conceals the coal, has been carried away, revealing its whole thickness, which is from 6 to 7 feet.

South of the Hocking valley, I have traced this coal over to the head waters of Raccoon in York and Waterloo townships. Here, it is somewhat thinner; and *south of this*, it is seen along the stream and branches before mentioned, in the townships of Lee, Brown and Vinton. In some places in the last township, it is below high-water mark; but in the southern part it is so elevated as to be easily wrought. It will be valuable as it is associated with iron ore, on a stream, which, doubtless, at some day, will be rendered navigable.

This coal, from its extent, will undoubtedly become the most valuable deposit on the western side of the coal-measures; and is destined to exert a powerful influence upon the prosperity of the part of the State which it traverses, as well as upon those which will be dependent on it for a supply of fossil fuel.

Dover coal.—About one and a half mile northeast from the point where the coal, just described, dips *below* the river, occurs a bed of coal about 40 feet *above*. It is found on section 33, township 10, range 14. It is about 4 feet in thickness, and has been used at the salt works for the evaporation of brine. There is some doubt whether this bed is *identical* with the Nelsonville coal, or *above* it in geological position. Sufficient data have not been collected to decide the question. If, however, it be identical, there must be a rapid *undulation of the rocks*, so as to *reverse* the dip, or they are *dislocated* so as to *depress one* portion *below* the bed

of the stream, while the *other* is elevated *above* it; giving the appearance of *two* distinct beds, while in reality there is but *one*. This question, though important, will not now be discussed; but it may be observed, that there is great probability that dislocations occur in the coal measures to such an extent, and in such a manner, as to cause us to over estimate the number of our beds of coal, and consequently the aggregate amount of this combustible in the State. In an economical view, the determination of this question is highly important, and can only be effected by accurate instrumental measurements, conjoined with careful observations of the succession of strata.

To return to the Dover coal: It has been opened in several places east of the locality first mentioned, as far as Sunday creek, at the mouth of which it is found near the bed of the stream, while, at the mouth of Bailey's run, it is a little more elevated. North of this, it extends into Trimble township. Beds of coal, in the same range, are found south of the river, in the eastern part of Waterloo and the western part of Athens. In the latter it has been opened in several places on a branch of the Hocking, called Factory run, where it is from 4 to 5 feet thick, overlain by slaty sandstone. What has been denominated the Dover coal, will average from 3 to 4 feet in thickness.

Coal above the "Calcareo-silicious" rock.

The coal before described, embraces the beds below the buhr, or "calcareo-silicious rock," in these counties. Above this stratum, which serves as a monument or guide in tracing the valuable deposits of the coal measures, are 4 or 5 layers of coal between the mouth of Sunday creek and the confluence of the Hocking and Ohio. Nearly all of these beds are too thin to be extensively wrought; but in other places, particularly in Muskingum county, as I am informed by Col. Foster, they are of much greater thickness. Near the town of Athens are some indications of coal, and some explorations have been made, but only thin beds have as yet been discovered, and those little used.

Federal creek coal.—In Dr. Hildreth's report of last winter, this stratum was described as the "Pomeroy coal," it being, no doubt, equivalent to that worked at Carr's run.

It is one of the most interesting and valuable deposits in the State, resembling, in its external character, the Nelsonville coal, but containing a greater quantity of sulphuret of iron. This mineral is generally found between the layers of the coal, in nodular masses, so as not to injure it much for ordinary purposes. On Federal creek, it is so abundant that it may be used in the manufacture of copperas. This bed of coal dips beneath the Hocking not far from the mouth of Federal creek, which is its eastern termination. West of this, it occupies an area from north to south, through the county, from six to ten miles in width, embracing the townships of Lodi, Carthage, Rome, Canaan, Ames, Bern, Marion and Homer. The coal is best disclosed in the last townships, along Federal creek and its branches. From a point about 2 miles above the mouth of this creek, it can be found on almost every section to the north part of

the county. It is not greatly elevated above the water, but rises in ascending the stream, the course being a little to the northwest. In the eastern part of Homer township it is elevated above the water courses, from 80 to 100 feet. The thickness of the coal, varies from 4 to 10 feet, while its average is not perhaps over 5. The greatest thickness, (10 feet,) was observed on Marietta run, a mile or two above its mouth, on some land owned by Messrs. Marsh and Root, of Athens. Here the coal is separated near the centre, by a layer of bituminous shale, about one foot in thickness. South of the river, in the townships before mentioned, the coal is somewhat thinner where it has been examined, but it is probably thick enough to be worked in almost any place.

This coal has not been worked, or even generally supposed to exist along the Hocking valley, although well exposed in some of the townships distant from the river. The examinations during the past season, however, render it nearly certain that, unless there be dislocations, it can be found on both sides of the Hocking river, continuing some miles above the mouth of Federal creek. But it is now effectually covered by land slides—arising from the argillaceous character of the strata,—and all outward appearance of its presence is concealed. From the extent of these slides, more than ordinary difficulty may be anticipated in opening the mines. Yet, the knowledge of the existence of this valuable bed of coal along the valley will greatly enhance the value of the land.

Above this deposit of coal, I have observed no workable beds; but, according to Dr. Hildreth, there is one about 4 feet in thickness, which he has denominated the "limestone coal." I am not aware that he has noticed it any where in Athens county; yet it may hereafter be found along the sides of the hills, below the mouth of Federal creek. It lies, according to this gentleman, about 120 feet above that last described.

In concluding this brief sketch of the coal deposits of these two counties, it may be well to glance at the potent influence which they are destined to exert upon their wealth and prosperity. This, however, will suggest itself to every reflecting mind. I will, therefore, dismiss the subject by stating that the aggregate amount of coal may be safely estimated at 3,000,000,000 tons. Here we have stored beneath the surface, in the most convenient form, a magazine of fossil fuel, which will not only supply the region, which it pervades, for ages, but will form an extensive article of commerce with other States.

6. IRON ORES.

It will be recollected that in my former report, it was stated, that most, if not all of the beds from which the furnaces in Lawrence and Scioto are supplied, are in geological position, below the buhr. I have traced these beds through the counties of Athens and Hocking, embracing the eastern part of the latter and the western part of the former. Their *eastern* limit may be represented by a line drawn from Vinton township to Trimble—while the *western*, may be indicated by a line drawn northeast, from the eastern part of T. 10, R. 18, to the eastern part of T. 15, R. 17. These lines are not, of course, precisely accurate, but are sufficiently so to

indicate the region in which we are to seek for a continuation of the valuable deposits of Lawrence, Scioto and Jackson. In a geological survey of a county, all that can be done, in most cases, is to direct in what situations explorations may be made with the greatest probability of success; at the same time, recording all such facts of a useful character, as may come within the knowledge of the observer. It has, therefore, been a primary object to ascertain the boundaries of the strata which embrace the ferruginous beds, and at the same time, to collect as much information as possible in reference to particular localities. As it was impracticable, in most cases, to identify beds at remote points, localities will be mentioned without reference to geological position. In all the townships between the lines before mentioned, there are numerous indications of iron ore; but in a very few places have efforts been made to develope the thickness and extent of the beds.

Iron ores of Hocking County.

A few years ago, some hundreds of dollars were expended in the vicinity of Logan in explorations for iron ore, without much success. It has, however, during the past season been observed in several places, and, at some of them, it may be valuable.

Bright's ore bed.—This is on the northeast quarter of section 1, township 14, range 17, about one mile and a half north of Logan. The ore comes out in large nodules, covered on the outside with layers of oxide of iron; while the interior is of a bluish color, very compact and heavy. This ore, externally, appears to be of a good quality, and is from 6 to 8 inches in thickness, and can be obtained in considerable quantities.

Monday creek ores.—Loose masses of good iron ore were observed on the branches of this creek in the townships of Falls and Green. No efforts have been made to ascertain the extent of the beds. Dr. Hildreth describes a bed of ore on this creek in Perry county, near Hazeltine's mills. "It is a rich heavy ore, one foot in thickness, and breaks out into tabular masses." He further remarks: "resting on the limestone* lies a thick deposit of slaty clay, containing thick masses of rich argillaceous iron ore. The lower portion near the buff limestone resembles ochre, and assumes a bright red color when roasted. The iron ore fills several feet of the deposit; but has not been sufficiently opened at McCormick's† beds to determine its value. In Green township, Hocking county, a few miles south of this place, on section 35, we find a similar ore imbedded in shale. On section 7, same township, is a valuable deposit of iron in a similar matrix, and lying in a similar geological position over the lime rock. Above the shale is a white sandrock, on which rests another deposit of ore which is about 10 inches in thickness, over which slaty clay supports a thin bed of

* The first bed described in the preceding part of this report.
† In the southeast corner of Perry county.

coal. It lies a little above the water on Seven-mile creek, 5 or 6 miles west of Nelsonville."

Crooks' ore bed, is in township 14, northwest quarter of section 15, range 18, about one mile and a half south of the Falls of Hocking. It seems to be bog ore and somewhat extensive. The thickness is more than 2 feet. Portions of this bed are tolerably good, while others are so intermixed with sand and gravel as to injure it materially.

Green's ore bed, is on section 23, in the same range and township as that above described, and about 2 miles south of Logan. It is of a good quality and occurs in very large masses; and from its abundance on the surface, may be found in sufficient quantities to be valuable. Mr. Green informed me that ore of a similar quality was observed on section 24, east of this locality. This ore occurs high in the hills, and has been traced along the south side of Hocking to the west line of Athens.

A similar ore occurs on section 9, Washington township. It is abundant on the surface, and from some excavations which have been made, is probably sufficiently thick to be workable. Indications of good ore were likewise observed on sections 19, 20 and 25, in Green township. These localities are on the south side of the river.

Wright's ore bed, is on the land of Judge Wright, Sec, 26, T. 12, R. 16, Star township. This is rather a remarkable deposit, differing, in many respects, from any hitherto observed. Its external appearance resembles bog ore, being ochreous and spongy. In some places it contains pieces of other ore, and ferruginous shale. The thickness of this bed is about 3½ feet, and, though not very rich, will doubtless be valuable either alone, or mixed with other ores. According to Dr. Hildreth, a similar ore is found on Sec. 1, T. 12, R. 17, about 8 miles west of Judge Wright's, as the uplands descend to the waters of Queer creek. This ore also occurs in the north part of T. 11, R. 16, on the waters of Raccoon creek.

In addition to these localities in Hocking county, indications of iron ore have been observed in the townships of Star, Swan, Washington, Jackson and Benton.

In the foregoing account I have omitted to mention a thick deposit of iron ore, containing so much silicious matter in the form of sand and pebbles, that it has not been wrought. In geological position, it is below the preceding beds. It can be examined to advantage on the land of Mr. Funk, Sec. 28, Falls township. For a more particular description, see Ohio Geological Report, 1837–8, note on page 89.

Iron ores of Athens County.

The most continuous, and probably the most valuable, deposit of iron ore in this county, is a few feet below the Nelsonville coal. This is a very heavy, compact ore, of a bluish color, and varies in thickness, from 6 to 10 inches. It contains impressions of ferns and other extinct vegetables. It is well disclosed at Whittimore's, on the Snow fork of Monday creek, resting on a bed of shale, which disintegrates

into a yellowish, ochrey clay. Split in the line of cleavage, it often reveals beautiful impressions of vegetables. Above it is a bed of shale containing nodules of good iron ore.* It continues up the branches of Monday creek, into the townships of Ward and Trimble; and throughout the whole distance, can probably be obtained in quantities sufficient to be valuable. In explorations for this ore, the Nelsonville coal affords a sure guide.

On the south side of the Hocking, it is well exposed on Meiker's run, T. 12, R. 15. It can be well examined in Waterloo township, along the branches of Raccoon creek, T. 11, R. 16, particularly on sections 10 and 11. Here the ore, externally, is excellent, and comes out in large slabs or plates containing fossil plants. The bed, here, is near the base of the hills, but rising as we travel westward, will be found in Hocking county, but at a much greater elevation. Southward it probably extends through the southeast part of Athens county. It also occurs on a branch of Raccoon creek, in the southwest part of York. There are other localities of ore which may belong to this stratum, on the branches of the Raccoon, in Lee township, and other places.

In the valley of the Hocking, the shale below the Nelsonville coal is rich in nodules of iron ore. This is the case in the neighborhood of Nelsonville, on both sides of the river. The best way, perhaps, to obtain these ores, is to trace them westward, till they rise so high in the hills that the incumbent materials can be removed without much labor.

Above this deposit are other beds, near or below the "calcareo-silicious rock." Some localities will be given in order to direct future explorations:

A bed of ore about one foot thick, was observed on the land of Mr. M'Laughlin, section 10, Waterloo township. Judging from its external appearance, it may be tolerably good, and sufficiently extensive to be valuable. By exploration in this vicinity, other localities will probably be found.

Near Mr. Lentner's, Lee township, large nodules of good ore were observed; and also, on a stream which passes through section 33, of the same township.

An ore of excellent quality occurs along the waters of Raccoon in Vinton township. It is, however, sometimes injured by being mixed with hornstone. This bed was penetrated by Mr. Royal Althar, in digging out a spring on section 20. It is about 2 feet thick at this place, and of a good quality, with the exception that it is associated with hornstone. This ore appears to be extensive, having been observed at several other places. It occurs on the land of Mr. David Jones, in Elk township, and in many places near McArthurstown.

About one mile east of this place, on section 22, northwest quarter, is a bed of good ochreous iron ore, about 4 feet in thickness. Its geolo-

* On the land of Mr. Whittimore is, also, a bed of ore above that just mentioned, which Dr. Hildreth regards as the equivalent to that in Hocking county, on the land of Judge Wright.

gical position is near the buhr. A similar stratum was observed in Jackson county.

The above are some of the most important localities where iron ore, suitable for smelting, has been observed; and, it is hoped that they may serve as an index to those who wish to make explorations with a view to the erection of iron works. There can be little doubt that a sufficient supply of ore may be obtained along the Hocking valley for this purpose, although the beds may be found to be thinner and less numerous than in Lawrence and Scioto, of which they are the equivalents. Furnaces along the canal may be supplied with ore from any of the beds adjacent to the Hocking. The bed below the Nelsonville coal, is of itself sufficient to supply several furnaces; but it must be wrought in situations where it can be obtained without much expense in removing the incumbent materials. When other beds from which ore can be obtained, are taken into consideration, their proximity to valuable beds of coal, and the facilities for transportation, we may reasonably conclude that this valley may hereafter become a favorable point for iron works.

It has been heretofore supposed that most of the valuable deposits of iron ore were *below* the "calcareo-silicious rock;" but the investigations of the past season, have shown that this is not the case. For in Tuscarawas, some of the most valuable beds are *above* this deposit; and I am informed by Col. Foster, that there are two beds in Muskingum county, occupying the same geological position.

With the knowledge of these facts, diligent search was made for iron ores *above* the buhr in Athens county, with some degree of success; but it is still doubtful whether they can be obtained in sufficient quantities to be valuable. Frequent indications are met with in the townships of Athens, Alexander, Lodi, Carthage, Troy and Canaan; and also, along the waters of Federal creek, in the townships of Rome, Berne, Marion and Homer: some of these localities were mentioned by Dr. Hildreth.* In Carthage and Troy, heavy masses of ore were observed in many places; but no opportunity occurred to ascertain the thickness of the beds from which they originated. Messrs. Beebe and Rowel, who live on the Hocking, below the mouth of Federal creek, intend to make the necessary explorations in their immediate vicinity.

TUSCARAWAS COUNTY.

Surface of the country—Geologicial position.—The surface of the country is uneven, consisting of labyrinths of hills formed by the ravines and water-courses which interrupt the continuity of the strata. This irregularity of surface has been, in part, produced by the abrading action of water, without disturbing the geological position of the rocks, so that they can be easily traced across the intervening valleys, from hill to hill. In this way vast stores of mineral wealth have been disclosed, which otherwise would have remained concealed in the bowels of the earth.

* See Ohio Geological Report, 1837-8.

The county is watered by the Tuscarawas and its tributaries. The main stream, bordered by narrow but fertile bottoms, sweeps through the county in a south or southwest direction; while the hills on either side, often rise to the height of 300 or 400 feet.

From the position of the county, as indicated on the vertical section, it will be observed that the strata which it embraces, belong exclusively to the coal measures; extending from a little below the "calcareo-silicious rock," to some hundred feet above, including a series of deposits rich in mineral treasures. The strata consist of alternations of sandstones, limestones, shales, coal and iron ores, together with the silicious deposit before mentioned. They dip slightly in a direction towards the south and east; and, the hills being high, the several deposits occupy, comparatively, large areas before they disappear beneath the water-courses. This peculiarity of surface, affords great facilities for mining operations.

The strata of this county, will be described under the following heads:

1. Buhr, or "calcareo-silicious rock."
2. Sandstones.
3. Limestones.
4. Shales.
5. Coal.
6. Iron ores.

1. "CALCAREO-SILICIOUS ROCK."

The only place where this rock was seen, in situ, is on the northwest quarter of Sec. 12, T. 8, R. 4. Here it occurs on the top of a hill, and it is possible that it may, on trial, be found of such a quality as to be used in the construction of millstones. This locality is mentioned in order to direct attention to this material which is so valuable in other places.

Black hornstone, or chert, into which it sometimes passes, was observed in the western part of the county, in the townships of Salem, Bucks and Sugar Creek. It was, in no locality, seen in place, but occurs in loose masses on the surface. This silicious deposit was the more carefully observed, as it affords an unerring guide to the most valuable deposits of the coal measures.

2. SANDSTONES.

These rocks predominate, forming probably more than two thirds of the strata in the county. Like the sandstones of Athens and Hocking, they are composed mostly of silicious sand, but sometimes intermixed with mica and argillaceous matter, and variously tinged with oxide of iron. They are generally, however, light colored; but contain so much oxide of iron as to change in color by the application of heat. They contain, also, in many localities feldspathic sand, the decompos

tion of which, renders the suface of the rock white, as if covered with fine kaolin.

The sandstones are useful for fine and coarse building materials, grindstones, flag-stones, tomb-stones, &c. Quarries can be opened in every township and almost on every section. Some of the most important quarries along the canal and water courses, only, will be mentioned, as they are so situated that the materials for construction can be transported to any point along the canal.

Zoar Quarry.—This is on the east side of the Tuscarawas, in township 10, range 2, near the village of Zoar. The lower part of the stratum is covered with debris, while about 30 feet of the upper portion has been wrought. The stone is rather fine-grained, micaceous, and, in some places, contains feldspar in a state of decomposition. It is easily quarried into blocks of suitable size for various purposes. Some of them are nearly white, while others are tinged with oxide of iron. Stone from this quarry has been wrought for locks and culverts on the canal; and also, used at Zoar in various architectural works.

Another quarry of beautiful sandstone has been wrought for locks and culverts, about 4 or 5 miles below Zoar. Between this point and Dover, other quarries sufficient to supply any demands, may be opened. A valuable quarry has been wrought to some extent, a mile or two below Dover on the land of Judge Blickensdorfer. This is near the canal, so that stone can be obtained at little expense. Good quarries have also been opened in the vicinity of New Philadelphia, Trenton, Gnadenhutten, Port Washington and Newcomers-town. At Trenton, on the land of Mr. Allen, good materials have been obtained for tomb-stones, window caps, &c. This locality will also afford good flag-stones.

On the Stillwater creek, 4 or 5 miles above Waterford, a good material has been quarried, on the land—I think—of Mr. Cathel, for tomb-stones and window caps. The stone is fine-grained and micaceous, and may be mistaken for the Waverly stone, which it strongly resembles.

On the waters of Connoton and Sugar creeks, materials both durable and beautiful, may be obtained.

As the sandstones are abundant, and the useful purposes to which they may be applied so well known, a further description at this time is deemed unnecessary. In some places, however, the sandstones of this county are liable to disintegration by reason of the feldspathic sand which they contain. Their durability, ought, therefore to be tested before they are used in any important work.

3. LIMESTONES.

Interstratified with the other rocks of this county, are several thin, but valuable beds of limestone. They occur above each other at such intervals, that they can be quarried on almost every section of land, though in many places, they are concealed by the superficial materials. The economical uses to which they may be applied, are the manufacture of quicklime, hydraulic lime, fluxes for ores, M'Adamizing roads; and some may be sufficiently compact to take a polish, so as to be used in ornamental

workmanship. Where the soil is deficient in carbonate of lime, these beds will be highly valuable for agricultural purposes.

Some of our limestones, doubtless contain more or less magnesia. This substance will render them less valuable for agricultural purposes and for fluxes; and hence the necessity of an accurate analysis of our limestones, not only in the vicinity of our iron works, but also in every part of the State. In this way much money might doubtless be saved in smelting operations. This is a subject of so much importance to iron masters, where there is a choice of fluxes, that none should be used before subjecting them to this process.

Hydraulic Lime.—There are one or two localities in the county at which hydraulic lime has been made. One is about a mile and a half or two miles a little southwest from Dover. Here the stone has been quarried, and hydraulic lime manufactured and used on the Ohio Canal, during its construction. The entire thickness of the stratum could not be observed, but it is probably from 10 to 12 feet, and is composed of layers from a few inches to a foot in thickness. The rock is compact, of a greyish or bluish color, and on exposure to the atmosphere often becomes yellowish from the iron which it contains.

This valuable stratum has been wrought a mile or two from the above locality, on the opposite side of the river, and about the same distance north of New Philadelphia. The dip of the stratum between the two places, as determined by Col. Whittlesey, is but a few feet.

By tracing this deposit with a level, other quarries may be opened in the county, though the stratum is now disclosed only in a few localities; the valuable qualities of the rock, however, may not obtain at all the places where it may be found.

There is a stratum of limestone in the eastern part of the county, on Stillwater creek, near Newport, from which, it is stated, water-lime has been manufactured. This limestone I could not observe when there, as it was high-water, and the rock near the bed of the stream.

Specimens of the limestones, for examination and analysis, were collected from various parts of the county, and it is believed, from every stratum.

4. SHALES.

The beds of shale in this county, are valuable in an economical view. They are, for the most part, argillaceous, but sometimes contain silicious sand and carbonate of lime. They are variable in color, being grey, black and red, and are interstratified with the other rocks, forming, in most cases, the floor and roof of the coal, and the matrix of the iron ores. They readily disintegrate into clays, which may be usefully applied to the manufacture of ordinary brick, fire-brick, and various kinds of pottery. They are also valuable in an agricultural point of view. The texture of sandy soils may be greatly improved by their application, and they are so abundant that some of the varieties may be found on almost every farm in the county.

As before observed, those which lie below the coal are the most valuable for fire-brick and pottery; and it is believed that clays for these purposes, can be obtained at almost any point along the Tuscarawas valley, and also in the interior of the county.

Potters' establishments have already been erected at Zoar and New-Philadelphia, on the Tuscarawas, and at Newport, on the Stillwater.

In the townships in the eastern part of the county, are found deposits of red shale, which, on exposure to the weather, produce reddish clays. These may probably be used as lithic paints, by burning and reducing them to the necessary degree of fineness.

Calcareous shales, which may be advantageously applied as mineral manures, have been observed only in two places, though, it is probable, they may be found in others. The first, is about two miles west of Zoar, on the land owned by the community of Germans at that place. It is about 4 feet in thickness, and filled with the remains of fossil shells. Here, situated as it is in a narrow and deep ravine, it will be of little value; but if the stratum be continuous, which is probable, it may be found in localities where it may be easily obtained for agricultural purposes.

The other locality is on the land of Mr. Heller, on Old Town creek, about three miles from New Philadelphia. It is incumbent on a bed of coal about four feet in thickness. A part only, of the shale, is calcareous; but if on further exploration it be found extensive, it will be valuable to the agriculturist.

5. COAL.

There is, probably, no county in the State which contains more coal than Tuscarawas. There are, at least, four or five beds of workable coal, occurring in the series of rocks, so that valuable mines may be opened on almost every square mile. It is, however, often concealed, and seldom appears at the surface. The coal is bituminous, and externally resembles that in other portions of the coal measures. The same bed often varies in thickness and character at remote points, and, even in short distances. Hence, coal which is good and workable at one place, may be in another, greatly diminished in thickness, or impaired in quality. These facts should always be kept in view in mining operations, that the prospect of success may be justly appreciated.

The coal of this county, though abundant, will not be immediately valuable, except along the line of the canal, and on the tributaries of the Tuscarawas which can be made navigable.

Coal of the Tuscarawas valley.—The line of the Ohio canal, which passes along this valley, is from 35 to 40 miles in length; and nearly or quite through the whole distance, the hills, on either side, contain valuable beds of coal, the average thickness of which may be from 4 to 5 feet. Not unfrequently the canal passes along the base of the hills, so that by the construction of railroads two or three hundred feet or yards in length, it can be conveyed to the boats which may be used in its transportation. The coal has been wrought at Newcomers-town, Port Wash-

ington, Gnadenhutten, Trenton and New Castle, immediately on the west bank of the canal; and, distant from it, in the vicinity of New Philadelphia, Dover and Zoar. At intermediate places, on both sides of the river, numerous mines ,without doubt, can be opened; but, in many instances the hills which contain the coal recede so far from the canal, that it will not come into immediate use, as it can be obtained with less expense at the localities first mentioned.

The greater portion of the coal which finds a market at Cleveland, is taken from this county, from the mines at New Castle a few miles below New Philadelphia. The principal mine is owned by Judge Blickensderfer of Dover, and is worked with more judgment and vigor than any in the county. This coal is well known in market, and, if I am correctly informed, is considered superior to that of many other localities. The mines in the vicinity of Trenton have, also, furnished coal for the Cleveland market. South of them, the coal is sent to Newark and Columbus. The shipments of this article from the Tuscarawas valley, during the past season, as furnished me by Mr. Ransom of the board of canal commissioners, amounts to 173,210 bushels, of which 87,000, were sent northward towards the lake.

Coal of the tributaries of the Tuscarawas.—We find beds of coal along the Stillwater, from its mouth to the southeastern part of the county, a distance of about 14 miles, following the meanderings of the stream. At some points there are two beds of coal, one above the other; as at Waterford, and at a few other places.

These deposits are the more valuable as they lie on the waters of a creek, which, with little expense, may be made navigable.

On the Connoton and Sandy, eastern tributaries of the Tuscarawas, valuable beds can also be opened, particularly on the former, with partial interruptions from its mouth to the eastern line of the county. They have been wrought at Leesburgh and New Cumberland.

On Sugar creek, which flows into the Tuscarawas from the west, I am not aware that any coal has been wrought; but it has been obtained for domestic purposes in several places a little distant from it, and it is highly probable that other mines more convenient for transportation, may be found when there shall be a sufficient demand for the coal.

Coal can also be obtained in great abundance, on Stone and Oldtown creeks. On the former, sufficient explorations have not yet been made to determine the full thickness of the beds; on the latter it has been mined in one or two places, but not extensively.

In Tuscarawas there are about 550 square miles, and at a rough calculation, it may be estimated that the whole amount of coal, including the beds after they have disappeared beneath the water level, is equal to an entire stratum 6 feet in thickness, over the whole county; and this is probably below the actual amount. One square mile of this, will yield about 6,000,000 of tons, which, multiplied by the number of square miles, will give 3,300,000,000 tons of coal. This will be sufficient, at a quadruple rate of consumption, to supply the people of this State for several centuries. This element of future wealth and

prosperity, will not always slumber in the bosom of the earth, but, stimulating enterprise and industry, it will exert a powerful influence upon the interests of this, and other parts of the State. The correctness of this conclusion will be seen, when we consider that the western part of Ohio, the eastern part of Indiana, Michigan, the Canadian towns, and the western part of New York, will be dependent on our coal measures, to a greater or less extent, for a supply of fuel for domestic and manufacturing purposes. And to all these points we can have access, either by our lakes and rivers, or by canals and rail roads, which will be completed as a part of that magnificent system of internal improvements on which we have already entered. It may, however, be thought by some that the forests of Ohio and the eastern part of Indiana, will of themselves be sufficient to furnish those regions with an ample supply of fuel, for an indefinite period. But such can never be the case in a region so well adapted to agriculture, and embracing so large a portion of prairie country, which, in a few years, will hardly have woodlands sufficient to supply domestic fires, and the materials for enclosing the farms and constructing the houses. Our magnificent forests, even now, are fast disappearing before the axe of the settler; and, from the wanton waste every where made of our most valuable woodlands, the day is not far distant when this state of things must be realized,—and then will our bituminous coals form an extensive and lucrative article of commerce. This prospective view of the future extent of our coal trade has been given, that the value of these extensive deposits, both in the valley of the Tuscarawas, and in other parts of the State, may be properly appreciated.

6. IRON ORES.

The several layers of iron ore, in this county, are higher in the geological column, than the "calcareo-silicious rock;" which, in most cases, serves as a guide to them. There are three or four workable beds separated from each other by layers of sandstone, shale, &c. They dip slightly to the east or southeast, so that they can be worked over a large area, before they sink beneath the water courses.

The lower beds of ore, have been extensively wrought in townships 9 and 10, range 2; and township 10, range 1. The ore is imbedded in dark colored shale, and consists of courses of nodules, compact and blue within, but externally composed of concentric layers of a yellowish color, which exfoliate on exposure to the atmosphere. For this reason, the term "shell ore" has been given, by the miners, to this variety. It is of an excellent quality, and has been wrought to supply the Zoar furnace, the Granville furnace in Licking county, and the furnaces at Massillon and Akron. The numerous openings from which this ore is obtained, are indicated on the map of the county, and need not, therefore, be particularized. The ore is obtained in the same manner as those in Scioto and Lawrence, of which a description was given in a former report.

Above the ore just described, are other beds, which are wrought in Fairfield, Tp. 9, R. 1, and used at the Fairfield furnace. The principal stratum which has been wrought, varies from 3 to 12 feet in thickness where it has been opened; and, in one instance, I am informed, a face of 15 feet was uncovered.

This bed alone will yield sufficient ore to supply several furnaces. The quality is not so good as that used at the Zoar furnace, containing in some places, so much impurity as to injure it for the manufacture of iron. At the Fairfield furnace, it is mixed with a dark colored shaly ore containing only from 15 to 25 per cent. of iron. In this way, it is more easily smelted, while the fuel necessary for its reduction is much diminished. As none of these ores have been analyzed, a full description of them, at this time, is not intended; and, therefore, facts as to their range and extent, can only be expected.

The Zoar and Fairfield furnaces are the only ones yet erected in this county, notwithstanding the quantity of ore which has been found to exist.

The localities before mentioned are in the northern part of the county; southw..rd, the beds have been traced to the southern boundary; but, as none of them have been explored, their extent, and in some instances the quality of the ore, remains unknown. In many places, loose masses are abundant on the surface, and in a few instances the layers have been accidentally penetrated.

A mile or two south of Dover, large heavy masses of iron ore have been thrown out on the top of a hill in digging graves. Here the stratum is said to have been penetrated three or four feet; and on the lands adjacent are indications that the deposit is extensive.

A bed about one foot in thickness, and of excellent quality, was shewn me by Mr. Seyton of New Philadelphia. It occurs along the river hills two or three miles above that place, and a few yards from the bank of the Tuscarawas. It appears to be continuous and abundant.

On the road from New Cumberland to New Philadelphia, ore was seen in large masses near the southern line of township 10, range 1; and from indications on the surface, appears to be abundant.

It is needless to mention all the localities where indications of iron ore were observed; but it should be stated that it appears in numerous places along the hills which border Stone, Oldtown, Connoton and Sugar creeks; and it is believed that it can be obtained from them in large quantities.

From an examination of these valuable deposits, they are deemed sufficient to supply the raw material for a great number of furnaces. But extensive as they are, their value can never be fully realized till our bituminous coals shall have been brought into use as a substitute for charcoal in smelting operations, as the forests in the vicinity of our furnaces will soon be exhausted, so that the manufacture of iron must be comparatively limited. Hence, the necessity of a thorough examination and accurate analysis of our coals with reference to the introduction of coke. If this can be effected, of which there is little

doubt, iron can be made with far less expense, while this branch of industry can be carried to any extent which the wants of the community may require.

MINERAL SPRINGS.

There are a few mineral springs in this county, which may be valuable for their medicinal properties.

About one mile and a half east of Zoar, is a sulphur spring, owned by the community of Germans at that place. It has been used with some success for medicinal purposes; and, water from it was put up for analysis. There is also another sulphur spring which may be of some value, on the farm of Dr. English, three or four miles north of New Philadelphia.

Chalybeate waters, formed from the decomposition of iron pyrites in the coal, and the adjacent strata, are very common.

One spring of this character was observed on the land of Mr. Wright, a little west of Newcomers-town. It issues from the base of a ledge of sandstone, and deposits oxide of iron in considerable quantities. This water, will, without doubt, be valuable as a tonic in some diseases,

Salt springs.—This county has been examined with particular reference to the probability of obtaining water which may be valuable in the manuafacture of salt. No definite opinion can be formed on this subject, from the fact that great uncertainty must necessarily attend all borings in search of salt water. It has, however, been ascertained that the whole of this county is underlain by the salt-producing strata, so that there is scarcely a doubt that brine may be obtained in almost every place; but its strength and quantity will be very uncertain. If borings, however, should be attempted, they must be carried from 800 to 1200 feet, as the rocks which contain the saline matter in the greatest abundance, lie far below the surface; and, as in the best districts, they are always attended with much uncertainty, several must be made before the question as to the existence of water in sufficient quantities to be valuable, can be determined.

On the Stillwater, salt was formerly manufactured in small quantities. A well was bored to the depth of 500 feet, and the water continued to increase in strength, till the work ceased. It was then sufficient to make two or three barrels of salt per day; 250 or 300 gallons being required to make a bushel. This is the only place where salt is known to have been made in the county; and this boring, so far from being an adverse, is a favorable indication. On account of the dip, borings made at New Philadelphia, or on Sugar creek, would be likely to reach the water at a shorter distance than in the eastern part of the county. If good wells can be obtained, no county will furnish greater facilities for the manufacture of salt, both as regards fuel and the means of transportation. But it should be borne in mind that success is uncertain, while all trials will be attended with much expense.

It will be seen from the above description of Tuscarawas, that its vast stores of mineral wealth, have not hitherto been appreciated.

REPORT

ON THE

ZOOLOGY OF OHIO.

BY PROF. J. P. KIRTLAND, M. D.

CINCINNATI, *November* 1, 1838.

Lieut. W. W. MATHER, *Chief Geologist:*

I have the honor to inform you that I resumed the performance of my duties as assistant geologist on the first day of last March, and have been actively engaged in the service of the State up to the present time.

The labor of collecting and arranging the productions of the *recent* animal and vegetable kingdoms of Ohio having been assigned to me, in the organization of the Geological Board, I proceeded to investigate the following classes of natural productions, viz:

1. Mammalia.
2. Birds.
3. Reptiles.
4. Fishes.
5. Testacea.
6. Crustacea.
7. Insects.
8. Plants.

It was my first intention to make out a catalogue which might be considered perfect, embracing these several classes, with the orders, genera, and species belonging to them—adding such notes and observations as might be useful or interesting to the public; and also to figure and describe every new species, but in no instance to admit any on doubtful authority, or that is not well established. In order to accomplish the undertaking in such a manner, a vast amount of both mental and physical labor was required, it being necessary for me to examine personally, as far as practicable, all of the immense number of species comprehended under these classes found within our limits.

The State of Ohio having engaged in the geological survey, apparently with a determination to persevere until its completion, I was determined that no efforts should be spared to complete in such a manner that portion of the undertaking which was committed to my charge.

Not doubting that both time and means were to be afforded for its accomplishment, I devoted the last season almost exclusively to securing and preserving specimens—deferring their investigation and scientific arrangement until I should receive a number of rare but necessary publications, obtain the opinions of several distinguished naturalists, and have an opportunity to examine the collections in several of the Atlantic States. I pursued the same course at the commencement of the present season, but upon learning that the Legislature had taken a step that indicated a determination to abandon the further prosecution of the survey, I did not feel myself warranted in pursuing the plan upon which I commenced. Under existing circumstances, I hastened without delay to arrange my collections and make out catalogues, though I could not at that time avail myself of the essential aids to which I have before alluded. My efforts were in a measure premature, but I deemed the course to be correct, under existing circumstances, as it will place their results, imperfect as they are, before the public, and serve to illustrate many points in the natural history of our State, in case the survey should be discontinued; and should it be hereafter resumed, would facilitate the labors of my successor.

In any future revision of the following catalogues, few or no erasures of species will be required, unless it be in the class Testacea, where some varieties may have been admitted as species. To the class Mammalia several species probably may yet be added. A number may also be added to that of birds. I have indications of several aquatic species that occasionally visit the shores of Lake Erie, but have not had an opportunity to ascertain their characters; and it is also probable that some southern land birds visit the Miami valley that have escaped my observation. No important additions can be made to the class of reptiles, except to the genus Coluber. I have on hand two or three undescribed species, and have indications of the existence of perhaps a greater number.

I have devoted considerable time and attention to the fishes of the western waters, and succeeded very satisfactorily in settling their scientific arrangement. The subject was involved in great obscurity. My catalogue contains seventy-two species. Of these, sixty-four had been noticed by authors; the remaining eight had escaped observation. These I have figured and have prepared full descriptions of, for publication. I have also indications of several additional species in the waters of Lake Erie and the Ohio river, but could not obtain specimens that would enable me to designate their names and places in this catalogue. It was originally my intention to prepare accurate descriptions, both scientific and popular, of all the species of fish found within our State, and to have them included in my final report, accompanied with correct drawings. I have already completed the design so far as to prepare the drawings and descriptions of one-third of the most rare, but did not

think it advisable to have this portion published till the whole was completed.

The class of Testacea is very full and complete. Probably no other State or country can exhibit as numerous a list of the Naiades as Ohio.

The class of Crustacea is, on the other hand, as meagre in species. Few additions can, however, be made to my list.

I have made extensive collections of insects, but time has not been allowed me to attempt arranging many of them. The same cause also prevents me from laying before you a tolerably full catalogue of Plants.

It will afford me the greatest pleasure to communicate much important matter connected with my pursuits to my successor, should the survey be hereafter continued. I am in possession of many interesting facts and specimens which would essentially aid him, all of which will be at his service.

Before closing this communication, permit me to say that I feel myself under great obligations to a number of scientific gentlemen for the aid they have rendered, and to the public generally for the encouragement and assistance they have invariably bestowed on me while engaged in my scientific investigations.

I am, sir, very respectfully yours,

JARED P. KIRTLAND.

A CATALOGUE of the Mammalia, Birds, Reptiles, Fishes, Testacea, and Crustacea in Ohio, by JARED P. KIRTLAND, M. D. *Assistant Geologist, and Professor of the Theory and Practice of Medicine in the Medical College of Ohio at Cincinnati.* *

EXPLANATION.—An asterisk or mark standing before the number of a species, refers to a similar character and number under the same class in the notes and observations.

Class I.

MAMMALIA.

Order I. CANNASIER.

*1	Vespertilio Noveboracensis	Linnæus	*Red Bat*
*2	" pruinosus	Say	*Hoary Bat*
*3	" rufus	Warden	*Brown Bat*
*4	Sorex brevicaudus	Say	*Short-tailed Shrew*
*5	" Dekaii	Bauchman	*Dekay's Shrew*
*6	Scalops Canadensis	Cuvier	*Mole*
*7	Condylura cristata	Desmarest	*Star-nose Mole*
*8	Ursus Americana	Pallas	*Black Bear*
9	Procyon lotor	Lin.	*Raccoon*
*10	Gulo luscus	"	*Wolverene*
*11	Mustela vulgaris	"	*Weasel*
*12	" erminea	"	*Ermine*
*13	" Canadensis	"	*Fisher*
14	" vison	"	*Mink*
*15	" martes	"	*Pine Martin*
16	Mephitis Americana	Desm.	*Skunk, Polecat*
*17	Lutra Brasiliensis	"	*Otter*
*18	Canis lupus	Lin.	*Wolf*
*19	" latrans	Say	*Prarie Wolf*
*20	" fulvus	Desm.	*Red Fox*
*21	" cinereo-argentatus	Gmelin	*Gray Fox*
*22	" decussatus	Geoffroy	*Cross Fox*
*23	Felix concolor	Lin.	*Mountain Tiger*
*24	" montana	Ency. Rev.	*Mountain Cat*
*25	" Canadensis	Geoff.	*Lynx*
*26	" rufa	Pennant	*Wild Cat.*

Order II. MARSUPIALIA.

27	Didelphis Virginiana	Pen.	*Opposum*

Order III. RODENTIA.

28	Sciurus Carolinensis	Gmel.	*Gray Squirrel*
29	" niger	Lin.	*Black* "
*30	" Hudsonius	Gmel.	*Red* "
31	" striatus	Klein	*Ground* "
32	Pteromys volucella	Lin.	*Flying* "
33	Arctomys monax	Gmel.	*Wood-chuck*
*34	" tridecemlineata	Harlan	*Hood's Marmot*
*35	Mus decumanus	Pal.	*Norway Rat*

36	Mus rattus	Lin.	*Black Rat*
*37	" musculus	"	*Common house Mouse*
38	" agrarius	Gmel.	*Rustic Mouse*
39	Meriones Canadensis	Fred. Cuvier	*Kangaroo Mouse*
40	Fiber zibethicus	Lin.	*Muskrat*
41	Arvicola xanthognata	Leach	*Meadow Mouse*
*42	" amphibius	Lin.	*Water-rat*
*43	" Floridiana	"	*Hairy-tailed rat*
*44	Castor fiber	"	*Beaver*
45	Hystrix dorsata	Gmel.	*Porcupine*
46	Lepus Americanus	"	*Rabbit*
*47	" Virginianus	Harlan	*Varying Hare*

Order IV. Ruminantia.

*48	Cervus Canadensis	Brisson	*Elk*
49	" Virginianus	Gmel.	*Deer*
*50	Bos Americanus	"	*Buffalo*

Class II.

BIRDS.

Order I. Accipitres.

Family I. Vulturini.

†1	Cathartes aura	Illiger	*Turkey Buzzard.*

Family II. Rapaces.

†2	Falco fulvus	Lin.	*Golden Eagle*
†3	" leucocephalus	"	*White-headed Eagle*
†4	" Washingtonianus	Audubon	*Washington's "*
5	" haliætus	Lin.	*Fish-hawk*
†6	" peregrinus	Gmel.	*Great-footed Hawk*
†7	" sparverius	Lin.	*Sparrow "*
†8	" columbarius	"	*Pigeon "*
†9	" palumbarius	"	*Goose "*
†10	" Pennsylvanicus	Wilson	*Broad-winged "*
†11	" velox	"	*Sharp-shinned "*
†12	" furcatus	Lin.	*Swallow-tailed "*
†13	" Sancti-Johannes	Gmel.	*Black "*
†14	" borealis	"	*Red-tailed "*
†15	" hyemalis	"	*Red-shouldered "*
†16	" cyaneus	Lin.	*Marsh "*
†17	" buteodes	Nuttal	*Short-winged "*
†18	" Cooperii	Aud.	*Cooper's "*
†19	Strix nyctea	Lin.	*Snow Owl*
20	" Asio	"	*Mottled "*
†21	" Virginiana	Gmel.	*Great-horned "*
†22	" brachyotos	"	*Short-eared "*
23	" nebulosa	Lin.	*Barred or round-head do.*
†24	" acadica	Gmel.	*Little screach "*

Order II. Passeres.

Family III. Psittacini.

†25	Psittacus Carolinensis	Lin.	*Parakeet*

Family IV. Amphiboli.

26	Coccyzus Americanus	Bonaparte	*Yellow-billed Cuckoo*
27	" erythrophthalmus	"	*Black-billed* "

Family V. Sagittilingues.

28	Picus auratus	Lin.	*Golden-winged Woodpecker*
29	" pileatus	"	*Pileated* "
30	" erythrocephalus	"	*Red-headed* "
†31	" varius	"	*Yellow-bellied* "
32	" Carolinus	"	*Red-bellied* "
33	" villosus	"	*Hairy* "
†34	" pubescens	"	*Downy* "
†35	" medianus	Swainson	*Little* "

Family VI. Anguilirostres.

36	Alcedo alcyon	Lin.	*King-fisher*

Family VII. Gregarii.

37	Sturnus Ludovicianus	Lin.	*Meadow Lark*
38	Icterus Baltimore	Daudin	*Baltimore Oriole*
39	" spurius	Bonap.	*Spurious* "
40	" Phœniceus	Daud.	*Red-wing Black-bird*
†41	" pecoris	Temmick	*Cow-bunting*
42	" agripennis	Bonap.	*Rice-bunting*
†43	Quiscalus versicolor	Viellot	*Crow Black-bird*
44	" ferrugineus	Bonap.	*Rusty Grakle*
†45	Corvus corax	Lin.	*Raven*
†46	" corone	"	*Crow*
47	" cristatus	"	*Blue Jay*

Family VIII. Sericati.

48	Bombycilla Carolinensis	Briss.	*Cedar-Bird.*

Family IX. Chelidones.

†49	Caprimulgus vociferus	Wil.	*Whip-poor-will.*
50	" Virginianus	Briss.	*Night-hawk.*
51	Cypselus pelasgius	Tem.	*Chimney Swallow.*
52	Hirundo purpurea	Lin.	*Martin.*
53	" rufa	Gmel.	*Barn Swallow.*
†54	" fulva	Viell.	*Cliff* "
55	" bicolor	"	*White-bellied Swallow.*
56	" riparia	Lin.	*Sand Swallow.*

Family X. Canori.

57	Muscicapa tyrannus	Briss.	*King-bird*
58	" crinita	Lin.	*Crested Fly-catcher*
59	" fusca	Gmel.	*Phœbe*
60	" virens	Lin.	*Wood Pewee*
61	" acadica	Gmel.	*Small Fly-catcher*
62	" ruticilla	Lin.	*Red-Start*
63	Icteria viridis	Bonap.	*Yellow-breasted Chat*
64	Vireo flavifrons	Viell.	*Yellow-throated Fly-cat-*
65	" Nove Boracensis	Bonap.	*White-eyed Vireo* [*cher*
†66	" gilvus	"	*Warbling* "
67	" olivaceus	"	*Red-eyed* "
†68	Lanius septentrionalis	Gmel.	*Butcher-Bird*
†69	Turdus polyglottus	Lin.	*Mocking-Bird*
70	" felivox	Viell.	*Cat-Bird*
71	" migratorius	Lin.	*Robin*
72	" rufus	"	*Brown Thrush*
73	" mustelinus	Gmel.	*Wood* "
74	" minor	"	*Hermit* "
75	" Wilsonii	Bonap.	*Wilson's* "
76	Sylvia aurocapilla	"	*Golden crowned Thrush*
†77	" coronata	Latham	*Yellow-rump Warbler*
†78	" maculosa	"	*Black & Yellow* "
†79	" maratima	Wilson	*Cape-May* "
†80	" pardalina	Bonap.	*CanadaFly-catcher* [*bler*
†81	" virens	Lath.	*Blk-throated GreenWar-*
†82	" Blackburniæ	"	*Blackburnian Warbler*
†83	" Nove Boracensis	"	*Water Thrush*
†84	" icterocephala	"	*Chesnut-sided Warbler*
†85	" castanea	Wil.	*Bay-Breasted* "
†86	" striata	Lath.	*Black-poll* "
†87	" varia	"	*Black & White Creeper*
†88	" æstiva	"	*Yellow Warbler*
†89	" Americana	"	*Parti-colored* "
†90	" Canadensis	"	*Blk-throated Blue Warb.*
†91	" agilis	Wil.	*Connecticut* "
†92	" trichas	Lath.	*Maryland Yellow throat*
†93	" azurea	Stephens	*Cœrulean Warbler*
94	" cœrulea	Lath.	*Blue-gray Fly-catcher*
†95	" Wilsonii	Bonap.	*Black-capt Warbler*
†96	" vermivora	Lath.	*Worm-eating* "
†97	" solitaria	"	*Blue-winged Yel.* "
98	" petechia	"	*Yellow-red-poll* "
†99	" chrysoptera	"	*Golden-winged* "
†100	" peregrina	Wil.	*Tennessee* "
†101	" rubracapilla	"	*Nashville* "
102	Saxicola sialis	Bonap.	*Blue Bird*
†103	Anthus spinoletta	"	*Brown Lark*
†104	Regulus calendula	Step.	*Ruby-crowned Wren*
105	" cristatus	Viell.	*Golden-crested* "
106	" tricolor	Nuttal	*Three-colored* "
†107	Troglodytes Ludovicianus	Bonap.	*Great Carolina* "
108	" palustris	"	*Marsh* "
109	" Europæus	Leach.	*Winter* "

Family XI. TENUIROSTRES.

110	Certhia familiaris	Lin.	*Browncreeper [Nuthatch*
111	Sitta Carolinensis	Briss.	*White-breasted blk. capt*
112	" Canadensis	Lin.	*Red-bellied Nuthatch*
†113	" pusilla	Lath.	*Brown-headed "*

Family XII. ANTHOMYZI.

114	Trochilus colubris	Lin.	*Humming Bird*

Family XIII. ÆGITHALI.

115	Parus bicolor	Lin.	*Tom-Tit*
116	" atricapillus	"	*Black-capt Titmouse*

Family XIV. PASSERINA.

†117	Alauda alpestris	Lin.	*Shore Lark*
†118	Emberiza nivalis	"	*Snow-bunting*
119	Tanagra rubra	"	*Scarlet Tanager*
†120	" æstiva	Gmel.	*Summer Red Bird*
†121	Fringilla cyanea	Wil.	*Indigo Bird*
†122	" Americana	Bonap.	*Black-throated Bunting*
†123	" leucophrys	Tem.	*White-crowned "*
124	" Pennsylvanica	Lath.	*White-throated Sparrow*
125	" graminea	Gmel.	*Bay-winged Bunting*
126	" melodia	Wil.	*Song Sparrow*
†127	" hyemalis	Lin.	*Snow Bird*
128	" passerina	Wil.	*Yellow-shouldered Finch*
129	" Canadensis	Lath.	*Tree Sparrow*
130	" socialis	Wil.	*Chipping Sparrow*
131	" pusilla	"	*Field "*
132	" palustris	"	*Swamp "*
133	" tristis	Lin.	*Yellow Bird*
†134	" linaria	"	*Lesser Red Poll*
135	" iliaca	Merrem.	*Fox-colored Sparrow*
136	" erythropthalma	Lin.	*Towhe Bunting*
†137	" cardinalis	Bonap.	*Cardinal Gross Beak*
†138	" Ludoviciana	"	*Rose-breasted " "*
†139	" purpurea	Gmel.	*Purple Finch*
†140	Loxia curvirostra	Lin.	*Common Cross-bill*

Family XV. COLUMBINI.

141	Columba Carolinensis	Lin.	*Mourning Dove*
142	" migratoria	"	*Passenger Pigeon*

Order III. GALLINÆ.

Family XVI. GALLINACEA.

143	Meleagris gallopavo	Lin.	*Wild Turkey*
144	Perdix Virginiana	Lath.	*Quail or Patridge*

145	Tetrao umbellus	Lin.	*Ruffed Grouse*
†146	" cupido	"	*Praire-Hen*
†147	" canadensis	Lin.	*Spotted Grouse*

Order IV. GRALLÆ.

Family XVII. PRESSIROSTRES.

†148	Charadrius semi-palmatus	Bonap.	*Ringed Plover*
149	" vociferus	Lin.	*Kildeer*
†150	" pluvialis	"	*Golden Plover*
†151	" helviticus	Bonap.	*Black-bellied do.*
†152	Strepsilas interpres	Ill.	*Turnstone*

Family XVIII. HERODII.

†153	Grus Americana	Tem.	*Hooping or Sand-hill*
154	Ardea Herodias	Lin.	*Great Heron [Crane*
†155	" egretta	Gmel.	*Great White Heron*
†156	" discors	Wil.	*Night "*
†157	" minor	"	*American Bittern*
158	" virescens	Lin.	*Green Heron*
159	" exilis	Wil.	*Least Bittern*

Family XIX. LIMICOLÆ.

†160	Numenius longirostris	Wil.	*Long-billed Curlew*
†161	" Hudsonicus	Lath.	*Esquimaux " [per*
162	Tringa semipalmata	Wil.	*Semi-palmated Sand-pi-*
†163	" Schinzii	Brehm.	*Schinz's Sand-piper*
164	" rufescens	Viell.	*Buff-breasted "*
165	" Wilsonii	Nutt.	*Wilson's "*
†166	Totanus semi-palmatus	Tem.	*Willet*
167	" melanoleucus	Viell.	*Great Yellow-shanks*
168	" flavipes	"	*Lesser " "*
†169	" Bartramius	Tem.	*Bartram's Tatler*
170	" chlorypygius	Viell.	*Solitary "*
171	" macularius	Tem.	*Spotted Sand-piper*
†172	Limosa fedoa	Viell.	*Marbled Good-wit*
†173	" hudsonica	Swain.	*Hudson "*
174	Scolopax grisea	Gmel.	*Red-breasted Snipe*
175	" Wilsonii	Tem.	*Snipe*
176	" minor	Gmel.	*Woodcock*

Family XX. MACRODACTYLI.

†177	Rallus Virginianus	Lin.	*Virginia Rail*
†178	" carolinus	"	*Carolina "*
†179	" nove boracensis	Bonap.	*Yellow-breasted "*
†180	Gallinula chloropus	Lath.	*Galtinule*

Family XXI. PINNATIPEDES.

†181	Phalaropus Wilsonii	Sabine	*Phalarope*

Family XXII. HYGROBATÆ.

†182	Recurvirostra Americana	Lin.	*Avocet*

Order V. ANSERES.

Family XXIII. LONGIPENNIS.

†183	Sterna aranea	Wil.	*Marsh Fern*
184	" hirundo	Lin.	*Great* "
185	" nigra	"	*Black* "
186	" arctica	Temm.	*Arctic* "
187	" Dougallii	Montfort	*Roseate* "
188	Larus capistriatus	Temm.	*Brown masked Gull*
189	" atricilla	Lin.	*Black-headed* "
190	" argentatus	Brunrick	*Herring* "
191	" marinus	Lin.	*Black-backed* "
192	" zonorhynchus	Swain.	*Ring-billed Mew*

Family XXIV. LAMELLOSODONTATI.

†194	Anser hyperboreus	Pallas	*Snow-Goose*
†195	" albifrons	Bechst.	*White-fronted Goose*
†196	" canadensis	Viell.	*Canada* "
†197	" bernicla	Bonap.	*Brant*
†198	Anas clypeata	Lin.	*Shoveler Duck*
†199	" strepera	"	*Gadwell*
†200	" acuta	"	*Pintail*
†201	" boschas	"	*Mallard*
†202	" Americana	Gmel.	*Widgeon*
†203	" obscura	"	*Dusky Duck*
†204	" sponsa	Lin.	*Summer or wood Duck*
†205	" discors	"	*Blue-winged Teal*
†206	" crecca	"	*American* "
†207	Fuligula rubida	Bonap.	*Ruddy Duck*
†208	" vallisnera	Steph.	*Canvassed-back* "
†209	" ferina	"	*Red-headed* "
†210	" marilla	"	*Blue-bill* "
†211	" rufitorques	Bonap.	*Ring-necked* "
†212	" clangula	"	*Golden-eyed* "
†213	" albeola	"	*Butter-ball*
†214	Mergus merganser	Lin.	*Goosander*
†215	" cuculatus	"	*Hooded Merganser*
†216	" serrator	"	*Red-breasted* "
†217	Cygnus musicus	Bescht.	*Swan*
†218	Pelecanus onocrotalus	Lin.	*Pelican*
†219	Podiceps cristatus	Lath.	*Crested Grebe*
220	" rubricollis	"	*Red-necked* "
221	" cornutus	"	*Horned* "
222	" carolinensis	"	*Pied* "
†223	Colymbus glacialis	Lin.	*Loon*

Class III.

REPTILES.

Order I. Chelonia—Tortoises.

Family I. Land-Tortoises.

‖1	Cistuda clausa	Say	*Box Tortoise*

Family II. Water-Tortoises.

‖2	Emys picta	Merrem	*Painted Tortoise*
‖3	" punctata	Harlan	*Spotted* "
‖4	" megacephala	Holbrook	*Large-headed* "
‖5	" geographica	Lesuer	*Geographical* "
‖6	" odorata	Harlan	*Musk* "
‖7	Chelonuria serpentina	Say	*Snapping Turtle*
‖8	Trionyx ferox	"	*Soft-shelled* "
9	" muticus	Lesuer	

Order II. Sauria—Lizzards.

‖10	Scincus quinquelineatus	Schneider	
11	" lateralis	Say	
‖12	Agama undulata	Harl.	

Order III. Ophidia—Serpents.

‖13	Coluber constrictor	Lin.	*Black Snake*
‖14	" sirtalis	"	*Garter* "
‖15	" punctatus	"	
‖16	" saurita	"	*Striped* "
‖17	" vernalis	"	*Green* "
‖18	" sipedon	"	*Water* "
‖19	" coccinœnus	"	*Red* "
20	" eximus	Dekay	*Milk* "
‖21	" obsoletus	Say	
22	porcatus	Bosc.	
‖23	Heterodon platirhinos	Hol.	*Flat-headed Adder*
‖24	" niger	Troost	
‖25	Trigonocephalus contortix	Hol.	*Copper-Head*
‖26	Crotalus durissus	Lin.	*Banded Rattlesnake*
‖27	" miliarius	"	*Massasaugua*

Order IV. Batrachia.

‖28	Menopoma Alleghaniensis	Harl.	*Young alligator*
‖29	Menobranchus lateralis	"	*Proteus of the Lakes*
30	Salamandra subviolacea	Barton.	
31	" dorsalis	Harl.	

32	Salamandra symmetrica	Harl.	
33	" bislineata	Green.	
34	" Jeffersoniana	"	
35	" glutinosa	"	
36	" porphyritica	"	
37	" cinerea	"	
38	" longa-caudata	"	
39	" intermixta	"	
40	" rubra-ventris	"	
41	" cylindracea	Harl.	
42	Rana pipiens	Linn.	*Bull-frog*
43	" clamata	Daud.	*Bawling Frog*
44	" halecina	Kalm.	*Shad "*
45	" palustris	Leconte.	*Pickerel "*
‖46	" sylvatica	"	*Wood "*
47	Hyla versicolor	"	*Tree-toad*
48	Bufo Americana	"	*Common Toad*

Class IV.

FISHES.

Sub-class I. OSSEUS FISHES.

Family I. PERCOIDES.

*† 1	Bodianus flavescens	Mitchell.	*Yellow Perch*
*† 2	Lucio-Perca Americana	Cuvier.	*Pickerel of the Lake*
*† 3	Pomotis vulgaris	"	*Sun-fish*
*† 4	Cichla ænea	Lesuer.	*Rock Bass*
*† 5	" Storeria	Kirtland.	*Grass "*
*† 6	" fasciata	Lesuer.	*Black Bass of the Lake*
*† 7	" Ohioensis	"	*" " of the Ohio*
*† 8	" minima	"	*Dwarf Bass*

Family II. BUCCÆ LORICATÆ.

*† 9	Gasterosteus inconstans	Kirtland.	*Stickle-back*

Family III. SCIENOIDES.

*†10	Sciœna grisea	Lesuer.	*White Perch of the Ohio*
*†11	" oscula	"	*Sheep's Head of the Lake*
*†12	Etheostoma caprodes	Rafenesque.	*Hog-fish*
13	" Blennioides	"	*Blenny like Hog-fish*
*†14	" maculata	Kirtland.	*Spotted "*
*†15	" variata	"	*Variegated "*

Family IV. CIPRINIDÆ.

*†16	Catostomus velifer	Rafenesque.	*Carp of the Ohio*
*†17	" aureolus	Lesuer.	*Mullet of the Lake*
*†18	" elongatus	"	*Missouri sucker*
*†19	" Duquesnii	"	*White sucker*
*†20	" erythurus	Rafenesque.	*Red Horse Sucker*
*†21	" bubalus	"	*Buffalo* "
*†22	" gracilis	Kirtland.	*Brook* "
*†23	" melanopsis	Rafenesque.	*Spotted* "
*†24	" nigrans	Lesuer.	*Mud* "
*†25	Exoglossum Lesurianum	Rafenesque.	*Rough-nosed Dace*
*†26	Hypentelium macropterum	"	*Stone-Toter*
*†27	Minnilus dinemus	"	*Silver-shiner*
28	Luxulus chrysocephalus	"	*Large* "
29	" erythrogaster	"	*Red-bellied Shiner*
*†30	" elongatus	Kirtland.	*Red-bellied (of the Lake)*
31	" Kentuckiensis	Rafenesque.	*White & Yellow-winged*
32	Semotilus cephalis	"	*Horned Chub*
33	" dorsalis	"	*Smooth-headed Chub*
34	" diplema	"	*Red-sided* "
*†35	Rutulus crysoleucas	Mitchell.	*Gold-shiner*
36	" compressus	Rafenesque.	*Flat* "
37	" amblops	"	*Chub-nosed Shiner*
*†38	Pimephelas promelas	"	*Fat-headed Chub*
*†39	Hydragira limi	Kirtland.	*Mud Minnow*

Family V. ESOCES.

*†40	Esox estor	Lesuer.	*Muskallonge*
*†41	" reticulatus	"	*Pike*
*†42	" niger	"	*Black Pike*

Family VI. SILURIDÆ.

*†43	Pimelobus cerulescens	Rafenesque.	*Blue Cat-fish*
*†44	" cupreus	"	*Yellow* "
*†45	" pallidus	"	*Channel* "
*†46	" nebulosus	"	*Mud* "
*†47	" xanthocephalus	"	*Bull-head*
*†48	Noturus flavus	"	*Yellow-back-tail*

Family VII. SALMONIDES.

*†49	Salmo manycash	Pennant.	*Mackinaw Trout*
*†50	" fontinalis	Mitchell.	*Speckled* "
*†51	Coregonus Artedia	Lesuer.	*Shad of the Lake*
*†52	" albus	"	*White-fish*

Family VIII. CLUPEÆ.

*†53	Pomolobus chrysochloris	Rafenesque.	*Gold Shad*
*†54	Chatoessus ellipticus	Kirtland.	*Hickory Shad*

*†55	Hyodon clodalus	Lesuer.	*Larger Herring*
56	" vernalis	Rafenesque.	*Lesser* "
57	" tergissus	Lesuer.	*Moon-eyed* "
*†58	Amia calva	Linn.	*Dog-fish*
*†59	Lepisosteus platostomus	Rafenesque.	*Duck-bill Gar*
*†60	" ferox	"	*Alligator* "
*†61	" oxyurus	"	*Common* "

Family IX. GADITES.

*†62	Lota maculosa	——	*Eel-pout*

Family X. ANGUILIFORMES.

*†63	Anguilla laticauda	Rafenesque.	*Broad-tailed Eel*
64	" xanthomelas	"	*Yellow-bellied Eel*

Sub-class II. CARTILAGENOUS FISHES.

Family XI. STURIONES.

*†65	Accipenser rubicundus	Lesuer.	*Sturgeon of the Lake*
*†66	" maculosus	"	*Spotted Sturgeon*
*†67	" Ohioensis	Rafenesque.	*Large Ohio Sturgeon*
*†68	" platorynchus	"	*Shovel-nose* "
*†69	Platinostra edentula	Lesuer.	*Paddle-fish*

Family XII. SUCTORII.

*†70	Petromyzon nigrum	Rafenesque.	*Black Lamprey*
*†71	" argenteus	Kirtland.	*Silvery* "
*†72	Ammocetes bicolor	Lesuer.	*Blind* "

Class V.

TESTACEA.

Bivalve Shells.

Genus MARGARITA.**

1. *Sub-genus, Unio.*

	1	Unio Æsopus	Green.
	2	" alatus	Say.
**	3	" anodontoides	Lea.
	4	" asperrimus	"
	5	" brevidens	"
**	6	" camelus	"
	7	" capsæforinus	"

	8	Unio	clavus	Lamark.
	9	"	circulus	Lea.
	10	"	coccineus	Hildreth.
	11	"	compressus	Lea.
**	12	"	Cooperianus	"
	13	"	cornutus	Barns.
	14	"	crassidens	Lam.
**	15	"	crassus	Say.
	16	"	cylindricus	"
**	17	"	declivis	"
	18	"	dehiscens	"
**	19	"	donaciformis	Lea
	20	"	Dorfeuillianus	"
	21	"	ebenus	"
	22	"	elegans	"
	23	"	ellipsis	"
	24	"	fabalis	"
	25	"	foliatus	Hild.
	26	"	fragosus	Conrad.
	27	"	gibbosus	Barns.
	28	"	glans	Lea.
	29	"	gracilis	Barns.
	30	"	graniferus	Lea.
	31	"	Hildrethianus	"
	32	"	iris	"
	33	"	irroratus	"
**	34	"	Kirtlandianus	"
	35	"	lævissimus	"
	36	"	lacrymosus	"
	37	"	lens	"
	38	"	luteolus	Lam.
	39	"	metanevrus	Rafinesque.
	40	"	multiradiatus	Lea.
**	41	"	multiplicatus	"
	42	"	mytiloides	Rafinesque.
	43	"	monodontus	Say.
	44	"	nasutus	"
	45	"	obliquus	Lam.
**	46	"	occidens	Lea.
**	47	"	orbiculatus	Hildreth.
	48	"	ovatus	Say.
	49	"	parvus	Barns.
	50	"	patulus	Lea.
**	51	"	perplexus	"
**	52	"	personatus	Say.
	53	"	phaseolus	Hild.
	54	"	pileus	Lea.
**	55	"	plicatus	Say.
	56	"	pustulatus	Lea.
	57	"	pustulosus	"
	58	"	pyramidatus	"
	59	"	Rangianus	"
	60	"	rectus	Lam.
	61	"	retusus	"

	62	Unio	rubiginosus	Lea.
**	63	"	Schoolcraftensis	"
	64	"	securis	"
	65	"	solidus	"
	66	"	subovatus	"
	67	"	subrotundus	"
	68	"	sulcatus	"
	69	"	tenuissimus	"
	70	"	triangularis	Barns.
	71	"	trigonus	Lea.
	72	"	tuberculatus	Barns.
	73	"	undulatus	"
	74	"	varicosus	Lea.
	75	"	ventricosus	Barns.
	76	"	venustus	Lea.
	77	"	verrucosus	Barns.
	78	"	zigzag	Lea.

2. *Sub-genus* MARGARITANA.

**	79	Margaritana	calceola	Lea.
	80	"	complanata	"
	81	"	marginata	"
**	82	"	rugosa	"

3. *Sub-genus* ANODONTA.**

83	Anodonta	Buchanensis	Lea.
84	"	decora	"
85	"	edentula	"
86	"	Ferrussaciana	"
87	"	imbecillis	Say.
88	"	ovata	Lea.
89	"	pavonia	"
90	"	Pepiniana	"
91	"	plana	"
92	"	salmonia	"
93	"	Wardiana	"

Univalve Shells.

1. *Genus* ANCYLUS.

94	Ancylus	rivularis	Say.

2. *Genus* HELIX.

95	Helix	albolabris	Say.
96	"	alternata	"
97	"	appressa	"
98	"	arboreus	"
99	"	clausa	"

100	Helix	concava	Say.
**101	"	diodonta	"
102	"	elevata	"
103	"	fallax	"
104	"	fraterna	"
105	"	fuliginosus	Griffith.
106	"	glaphyra	Say.
107	"	gularis	"
108	"	harpa	"
109	"	hirsuta	"
110	"	indentata	"
111	"	inflecta	"
112	"	inornata	"
113	"	interna	"
114	"	labyrinthica	"
115	"	ligera	"
116	"	lineata	"
117	"	minuta	"
118	"	Mitchella	Lea.
**119	"	multilineata	Say.
120	"	obstricta	"
121	"	palliata	"
122	"	Pennsylvanica	Green.
123	"	perspectiva	Say.
124	"	profunda	"
125	"	solitaria	"
126	"	tridentata	"
127	"	Wardiana	Lea.
128	"	zaleta	"

3. *Genus* POLYGYRA.

129 Polygyra Dorfeuilliana - - Lea.

4. *Genus* HELECINA.

**130 Heleciana ——— - - - ———

5. *Genus* PUPA.

131	Pupa	armifera	Say.
**132	"	exigua	"
133	"	ovata	"

6. *Genus* SUCCINEA.

134	Succinea	avara	Say.
135	"	ovalis	"
136	"	retusa	Lea.
137	"	vermetus	Say.

7. *Genus* CYCLOSTOMA.

138	Cyclostoma lapidaria	Say.
139	" marginalis	"

8. *Genus* PLANORBIS.

140	Planorbis armigerus	Say.
141	" bicarinata	"
142	" campanulata	"
143	" exacuous	"
144	" lens	Lea.
**145	" parvus	Say.
146	" trivolvis	"

9. *Genus* PHYSA.

147	Physa elliptica	Lea.
**148	" elongata	Say.
149	" heterostropha	"
**150	" Sayii	Tappan.

10. *Genus* LYMNEUS.

**151	Lymneus catascopius	Say.
152	" desidiosus	"
153	" elodes	"
154	" exilis	Lea.
155	" reflexus	Say.
**156	" stagnalis	Lam.
157	" umbrosus	Say.

11. *Genus* MELANIA.

158	Melania caniculata	Say.
159	" conica	"
160	" depygis	"
**161	" isogonica	"
162	" Sayii	Wood

12. *Genus* ANCULOSA.

**163	Anculosa præroea	Say.

13. *Genus* VALVATA.

**164	Valvata sincera	Say.
**165	" tricarinata	"

14. *Genus* PALUDINA.

166	Paludina decisa	Say.
**167	" granosa	"

**168	Paludina heterostropha	-	-	Kirtland.
**169	" microstoma	-	-	"

Class VI.

CRUSTACEA.

Family MACROURA.

1. *Genus* ASTACUS.

1	Astacus affinus	-	-	- Say.
2	" Bartonii	-	-	- Bosc.

NOTES AND OBSERVATIONS.

CLASS I. MAMMALIA.

Note *1. *V. noveboracensis*. The red bat is comparatively a rare animal. During the two last seasons I have succeeded in taking only six specimens in the northern part of the State. Its habits are similar to those of the common brown bat.

Note *2. *V. pruinosus*. The hoary bat is still more rare. I have met with only a solitary specimen, though I believe it is more common in the southern than northern counties of Ohio.

Note *3. *V. rufus*. The brown bat exists in great numbers, visiting our domicils at night in pursuit of insects. It is, however, an unwelcome visiter, on account of being infested with a parasitic insect which it is apt to deposit in houses, much to the annoyance of cleanly matrons. During the winter it remains dormant in clefts of walls, hollow trees and other secure retreats.

Mr. Dorfeuille, of Cincinnati, showed me a prepared specimen of another species of this genus, but I have had no opportunity to decide upon its character. In size, it greatly exceeds either of the preceding.

Note *4 and *5. *S. brevicaudus* and *S. Dekayii*. Both species of shrews are natives of our State; the last is the most common and is frequently captured, but I believe never eaten by cats. During severe winter weather they frequently resort to warm cellars. The first species does not exactly agree with Mr. Say's description, and it may prove to be only a variety of the Dekayii.

Note *6. *S. Canadensis*. The mole is rapidly increasing in numbers with the extension of cultivation.

Note *7. *C. cristata*. Star-nose mole. I have seen only one specimen of this singular animal, and that was taken by a cat in my orchard.

Note *8. *U. Americana*. It is generally believed, among western hunters, that two distinct species of bear formerly existed in this State.

One they designate as the brown bear, the other as the black, and say that they differed as much in their forms and habits, as in their color. Naturalists make only one species. A few still exist within our limits.

Note *10. *G. luscus.* The wolverene undoubtedly inhabited the northern parts of Ohio in former times, but has long been extinct.

Note *11. *M. vulgaris.* The weasel is becoming more common as the country becomes populated.

Note *12. *M. erminea.* The ermine. This beautiful animal is occasionally met with, but is mistaken for a *white weasel.*

Note *13. *M. Canadensis.* Two specimens of the fisher were taken in Ashtabula county in 1837, where a few probably still exist.

Note *15. *M. martes.* The pine weasel is admitted on the authority of Dr. Ward, who informs me that he has taken it in the vicinity of Chillicothe.

Note *17. *L. Brasiliensis.* The otter is still common. It can be domesticated without trouble, and will become as affectionate and docile as the house dog. It might be bred for its fur.

Note *18. *C. lupus.* The wolf is becoming very rare. A black colored species is said to have been a native of our State.

Note *19. *C. latrans.* I have some doubts as to the propriety of introducing the *prairie wolf* into the list of Ohio animals. It is a native of Michigan, and has probably at times been found in our northwestern borders.

Note *20. *C. fulvus* The red fox was unknown in this region of country until the introduction of the white population, and is supposed by many not to have been originally a native of America. It has now become a common and troublesome inhabitant.

Note *21. *C. cinereo-argentatus.* The grey fox was formerly very abundant, but it rapidly disappeared before the advancement of cultivation, and its place is now generally filled by a more cunning and sagacious successor, the red fox.

Note *22. *C. decussatus.* The cross fox receives its name from a light colored bar or cross on its back near its shoulders It was formerly killed on the Connecticut Western Reserve, and its fur was more valuable in market than that of the other species.

Note *23 and 24. *F. concolor* and *F. montana.* The mountain tiger and the mountain cat. The pioneer hunters blended both these species under the common name of *catamount*, and seemed not to know that they were distinct. They both formerly inhabited this State but have now disappeared. Mr. Dorfeuille has in his museum at Cincinnati, well prepared specimens of each species that were taken in Ohio.

Note *25. *F. Canadensis.* A lynx was killed in Trumbull county about ten years since. I believe none inhabit the State at this day.

Note *26. *F. rufa.* The wild cat is still found in the unsettled sections of the western country.

Note *30. *S. Hudsonius.* The red squirrel is one of the animals that becomes more numerous with the extension of cultivation. It is said to destroy the black and grey species, and also the young of

many kinds of birds. I have myself seen it committing its depredations on a brood of young robbins.

Note *34. *A. tridecemlineata.* Hood's marmot is found I believe only in the northwestern parts of Ohio, and there not very common.

Note *35. *M. decumanus.* The Norway rat is not a native of our country, but is now extending itself in every direction, especially along the shores of our canals and navigable streams. It carries on a war of extermination against our native black rat, and soon expels it from the neighborhood, but the people are not benefited by the exchange.

Note *37. *M. musculus.* The common mouse is not a native of this country. It found its way into the west many years since, and much earlier than the Norway rat.

Note *42. *A. amphibius.* The only authority I have for inserting the water rat among the Ohio animals, is a prepared specimen in Dorfeuille's museum, said to have been taken in Ohio.

Note *43. *A. Floridiana.* (Neotoma Floridiana, Say and Ord.) This species has been discovered by Dr. Ward on the Mohican bluffs. It lives under large stones and rocks, and is known among the people in that vicinity, as the "Hairy-tailed rat."

Note *44. *C. fiber.* The beaver. This valuable and interesting animal is now exterminated from our State, though it once existed here in great numbers. It is capable of domestication, and might probably be bred, as a business of profit, for its fur.

Note *47. *L. Virginianus.* The varying hare, first described by Dr. Harlan as a distinct species, is a rare animal, but is sometimes seen in the northeastern parts of our limits.

Note *48. *C. Canadensis.* The Elk was frequently to be met with in Ashtabula county, until within the last six years. I learn from Col. Harper of that county, that one was killed there as recently as October of the present season.

Note *50. *B. Americanus.* In former times the buffalo ranged extensively over the southern parts of our State. "Two were killed in the Sandy forks of Symmes' creek, near the southeastern corner of Jackson county, in the year 1800, which are the last that have been heard of in this State." (*Dr. Hildreth's letter.*)

CLASS II. BIRDS.

†1. *C. aura.* The turkey buzzard is common during the summer, but does not continue in the northern parts of our State during the winter. It formerly nested in considerable numbers on the banks of the Big Beaver, near the line of Pennsylvania and Ohio, within the limits of the former State. Its numbers have greatly diminished within a few years.

†2. *F. fulvus.* The golden eagle occasionally visits the shores of Lake Erie, and perhaps the Ohio river. Mr. Dorfeuille has seen a specimen taken within the limits of this State.

†3. *F. leucocephalus.* The bald eagle is both a summer and winter resident.

†4. *F. Washingtonianus.* Dr. Ward informs me that he once saw a well marked specimen of the Washington eagle on the hills adjacent to the Ohio river. Audubon discovered a pair on Green river in Kentucky. If it be *a true* species, we probably are entitled to its admission into the list of Ohio birds.

†6. *F. peregrinus* The great-footed hawk. I once shot a specimen of this beautiful hawk hovering over my orchard in pursuit of a flock of hens. It is the only one I have ever met with.

†7. *F. sparverius.* The sparrow-hawk. This handsome and harmless bird spends only the summer with us, during which it destroys large numbers of snakes, mice and reptiles, but never, I believe, makes any intrusion on our poultry yards.

†8. *F. Columbarius.* The pigeon-hawk. The true pigeon-hawk is rare, but may be seen early in autumn following the flocks of birds that are collecting for their migrations.

†9. *F. palumbarius.* I have never met with the goose-hawk, but insert it on the authority of Audubon, who says that "it is found in Kentucky, Pennsylvania, Indiana, and at the Falls of Niagara;" of course in Ohio.

†10. *F. Pennsylvanicus.* The broad-winged hawk is common, and breeds in the northern sections of the State. It is the mildest and most gentle in its manners of any of the hawk family.

†11. *F. velox.* The sharp-shinned hawk is equally common with the preceding species, and is the greatest plunderer of the flocks of hens and young turkies that is to be met with among the predaceous birds.

†12. *F. furcatus.* A few years since the swallow-tailed hawk was to be seen, during the summer, in considerable numbers in Portage and Stark counties. From some unknown cause it has, of late, ceased to visit those localities. They were probably the northernmost verge of its summer migrations, and the late cold and wet seasons have driven it back into warmer climates.

†13. *F. Sancti Johannes.* The black hawk is a rare visiter. I have seen only one specimen.

†14. *F. borealis.* The red-tailed hawk. This beautiful hawk spends the whole year with us, and may be easily distinguished from any other species both by its plumage and its horrid and unearthly scream. It is comparatively rare.

†15. *F. hyemalis.* The red-shouldered hawk is also a permanent resident with us, and much more common than the red-tailed.

†16. *F. cyaneus.* Marsh hawk. I have never met with this species, but am informed by Dr. Sager, assistant geologist of the Michigan geological board, that he has taken them on the Maumee river.

†17. *F. buteodes.* The short winged hawk. It is a matter of surprise that this species should have escaped the attention of naturalists until it was discovered by Nuttal, as it is the largest and one of the most common of the hawks in the northern parts of Ohio.

†18. *F. Cooperii.* Cooper's hawk. I killed a pair of this delicate looking hawk in Trumbull county in the autumn of 1837, the only specimens I have ever seen.

There appears to be considerable perplexity among naturalists in arranging the several members of this family. It can be easily obviated by attention to their habits, notes and plumage at different ages and stages of moulting. Their specific characters are distinct and well marked.

†19. *S. nyctea.* Snow owl. The large white owl sometimes visits this State during severe and long continued cold weather.

†21. *S. Virginiana.* Great horned owl. The great horned owl evidently has increased among us within a few years, probably deriving increased means of support from our domestic fowls. It is a bold depredator, but can be easily entrapped.

†22. *S. brachyotos.* During the last winter, which was severe and long continued, the short-eared owl frequently visited the orchards and barn yards, and was easily taken. A flock located themselves in the immediate vicinity of Warren, Trumbull county.

Note †24. *S. Acadica.* Both this species and the *S. asio* exist among us, but they are commonly blended together as one under the name of *Screach Owl.*

Note †25. *P. Carolinensis.* The Parakeets do not usually extend their visits further north than the Scioto, though I am informed on perhaps doubtful authority, that thirty years since flocks of them were sometimes seen on the Ohio at the mouth of Big Beaver, thirty miles below Pittsburgh.

Note †31. *P. varius.* The yellow-bellied and the red-headed woodpeckers are the only species of this genus that forsake us during winter—all the others are permanent residents.

Note †34. *P. pubescens.* The sap-sucker. This small bird is one of the most destructive enemies of our orchards. While they are visited by the other species to capture innumerable small insects and worms that infest and injure the trees, this bird appears to be intent on destroying the trees themselves, which it is sure to accomplish in the course of a year or two by encircling their bodies by a series of punctures through the bark. I am inclined to believe with the popular opinion that it does it for the sake of sucking the juices of the trees. It has long been known to people of observation that it always selects those trees in a sugar or maple grove that furnishes the sweetest sugar water, and it has its favorite trees in our orchards, and appears to select them without reference to age, thriftiness or any evident circumstance, but most likely according as they afford palatable food. While the visits of all the other species should be encouraged, even though they should occasionally mutilate or purloin a little fruit, it becomes the farmer and horticulturist to carry on a war of extermination against the sap-sucker.

Note †35. *P. medianus.* The small woodpecker. I have long been familiar with this small species, and considered it a non-descript, till

I recently found it noticed in the appendix to Nuttal's Ornithology at the close of the 2d vol.

Note †41. *I. pecoris.* The cow-bunting is admitted into our catalogue on rather doubtful authority.

Note †43. *Q. versicolor.* The black bird is one of the species against which the efforts not only of idle boys, but of our farmers are directed on account of its habits of attacking the Indian corn at the time it is sprouting from the ground. It is somewhat vexatious, to be sure, to have this injury done our corn crops; but before the farmer engages in the warfare against these birds. he should take into consideration the fact that they save ten times the amount of corn they destroy. They pick up thousands of insects that would do far greater damage.

There are only two short periods while the black birds remain with us that they eat vegetable food: in the spring when the corn is sprouting from the ground, and in autumn when it is mature. The remainder of their summer's sojourning is spent in rendering us the most essential aid. On opening the stomachs of these and many other insectiverous birds, they will be found to contain great numbers of worms, bugs and small reptiles; sometimes as many as fifty or sixty may be discovered in the stomach of one individual.

The farmer should recollect that in destroying even one of these birds he is committing a direct injury on his own property as well as injuring community at large. This cause, if no other, should induce parents and guardians who have the charge of idle boys to restrain them from waton destruction of the feathered tribes.

Note †45. *C. corax.* The raven sometimes spends the winter as far north as the south shore of Lake Erie.

Note †46. *C. corone.* From careful attention to the habits of the crow for many years, I am fully convinced that, like most of the smaller species of birds, it does the farmer far more service by destroying various insects, than injury by its depredations on the corn fields.

Note †49. *C. vociferus.* The whip-poor-will was formerly common in the northern counties of the State during summer, but for the last three years its notes are rarely if ever heard. The coldness of the weather has probably prevented its reaching so high a latitude.

Note †54. *H. fulva.* Congregations of the cliff or republican swallow are now common at the west. In the spring of 1815 a few were first seen by Audubon at Henderson in Kentucky. Four years after, a colony located on the United States buildings at Newport, opposite Cincinnati, and have more recently extended their settlements to several buildings in the west part of the latter city. During the present summer they have built their nests on a barn in the north part of Columbiana county.

Note †66. *V. gilvus.* The warbling vireo, from its small size and retiring habits, escapes the observation of most people, yet it is one of the sweetest of the feathered songsters. Contrary to the usual custom of these birds, a pair once took up their summer residence in

an apple tree a few rods from my house, where they nested and reared their young. The male would place himself on the topmost bough of the tree, and from the earliest dawn till the close of the day, would pour forth a continued strain of the most melting notes.

Note †68. *L. septentrionalis*. The butcher bird. During the long continuance of the cold in the northern sections of our State, this depredator is an occasional visiter, much to the annoyance of the smaller species of birds, which it destroys out of mere wantonness, and leaves their bodies hanging upon the boughs of trees.

Note †69. *T. polyglottis*. The mocking bird frequently visits the Miami valley, but is never seen in the northern counties of the State.

Note †77. *S. coronata*. The yellow-rump warbler. I have watched with much care for several years the numerous family of small birds comprised in the genus Sylvia, and am happy to be able, by my own observations, to lay before the public so complete a list of its species. Not one is admitted on doubtful authority. I have prepared specimens of all that are enumerated.

A majority of them remain with us only a few days during spring, on their way to the north, where they rear their young. On their return in autumn they do not often stop. A few species, however, spend the summer in this State and retire to the south early in autumn. The yellow-rumped warbler is of the former character. It is one of the most numerous in the spring, but soon disappears.

Note †78. *S. macalosa*. The black and yellow warbler is very rare; it is sometimes seen in company with the preceding species. It soon retires to the north.

Note †79. *S. maratima*. The Cape May warbler, Nuttal says, has "only been seen near the swamps of Cape May, in New Jersey, and near Philadelphia." I have succeeded in securing three specimens. Its habits are similar to those of the other transitory warblers. I discovered it picking insects from the cherry blossoms.

Note †80. *S. pardalina*. The Canada flycatcher was rather common about a cranberry marsh in Trumbull county, during most of the month of May of the present year.

Note †81. *S. virens*. The black-throated green warbler is a rare visiter during a few days in spring. It may generally be discovered searching for insects on the opening buds of the sugar trees.

Note †82. *S. Blackburniæ*. The Blackburnian warbler. Few of this family equal this bird in the beauty of its plumage. Its stay with us is short, but it often appears in considerable numbers.

Note †83. *S. Novæ Boracensis*. The water thrush appears about our small streams early in the spring, and a few continue during the whole of the summer, though most of this species pass on to the north.

Note †84. *S. icterocephala*. The chesnut-sided warbler which Audubon met with only in one instance, was rather common in Trumbull county during the last spring. I am inclined to believe it nested in our cranberry marshes, as I saw it on the first of June busily engaged in catching small insects and warbling its mild and soft notes.

Note †85. *S. castanea*. The bay-breasted warbler. This is es-

teemed one of the rarest of the Sylvias. I have however succeeded in taking great numbers during their short visits. They are generally found among the highest limbs of our forest trees, early in May.

Note †86. *S. striata*. The black-poll warbler is rather common about the orchards while the apple trees are in flower. It however remains but a few days.

Note †87. *S. varia*. The black and white creeper spends the summer with us, and is common.

Note †88. *S. æstiva*. The yellow warbler is another summer resident. It may often be seen weaving its thready nest on the extreme limbs of fruit trees.

Note †89. *S. Americana*. The delicate, parti-colored warbler, in some instances, spends the summer with us. I have repeatedly seen them feeding their young in the month of July.

Note †90. *S. Canadensis*. The black-throated blue warbler. This comely looking Sylvia is tolerably plenty for a few days in the spring. Its common resort at that time, is the retired forests, particularly the shadowy evergreens.

Note †91. *S. agilis*. I have taken only a solitary specimen of the Connecticut warbler, and am not familiar with its habits.

Note †92. *S. trichas*. The Maryland yellow-throat breeds in bushy marshes, and its notes are to be heard almost incessantly, in such situations, during the summer.

Note †93. *S. azurea*. The cœrulean warbler must be rare, as I have never met with it except in one instance.

Note †95. *S. Wilsonii*. The black-capt warbler. This bird, which Audubon has classed with the muscicapa or fly-catchers, partakes more of the Sylvias. I have therefore adopted Bonaparte's arrangement of it. It was common, during the last spring, about the cranberry marshes, where it continued till the middle of May.

Note †96. *S. vermivora*. The worm-eating warbler. This species may be seen, during the spring, engaged in seeking food in wet marshes and on the borders of small streams.

Note †97. *S. solitaria*. The blue-winged yellow warbler. I have obtained only one specimen of this delicate warbler, and remain ignorant of its habits.

Note †99. *S. chrysoptera*. The golden-winged warbler is one of the most delicate and showy of the genus, as well as among the most rare. I captured a few in May last, on the verge of a cranberry marsh. It is only a transitory visiter in Ohio.

Note †100. *S. peregrina*. The plain Tennessee warbler was common for two or three days in our orchards while in bloom during the last spring, but its visit was not prolonged beyond that time.

Note †101. *S. rubracapilla*. I took a solitary specimen of the Nashville warbler in my garden during the last spring, the only one I have ever seen. It was engaged, like most of the members of this family, in catching insects.

Note †103. *A. spinoletta*. Though the brown lark is probably abundant, at times, in Ohio, I have taken only one specimen. It stops with us while on its way to the north, and on its return.

Note †104. *R. calendula.* I have repeatedly taken this and the two succeeding species of wrens, but I consider it questionable whether they are more than varieties. If they be spocifically distinct, there is still another species not described, in which the crown is destitute of the colored feathers. I have taken several with this plain character.

Note †107. *T. Ludovicianus.* The great Carolina wren was common at Cincinnati during the last winter. I have not seen it north of that city.

Note †113. *S. pusilla.* The brown headed nuthatch. I once killed a specimen in the northern part of Ohio, though it is usually not seen north of Virginia.

Note †117. *A. alpestris.* The shore lark is frequently seen late in autumn on the shore of Lake Erie, in the vicinity of Cleveland, and in one instance I met with it in Trumbull county during winter.

Note †118. *E. nivalis.* The snow bunting visits us only during the most intense cold weather, when it is compelled to leave its northern haunts in search of food. It may then be seen gathering scattered seeds by the road side or about our barns and gardens. A late voyager gives an account of his having examined a burial crib containing the body of a dead infant, deposited according to the customs of some of the northern Indians. A white snow bird had constructed her nest on the neck of the corpse, and was quietly sitting on her eggs. No one who has read that account can see this delicate looking bird shivering in our winter blasts, without bringing the impressive incident to mind.

Note †120. *T. æstiva.* The summer red bird is occasionally seen in the southern parts of Ohio, and I have in one instance met with it as far north as Trumbull county.

Note †121. *F. cyanea.* The indigo bird is a summer resident in all parts of the State, and enlivens our gardens by its constant chatterings.

Note †122. *F. Americana.* The black-throated bunting. My authority for admitting this species into our catalogue is perhaps not sufficient. I however believe it to be an occasional visiter of this State.

Note †123. *F. leucophrys* and *F. Pennsylvanica* so closely resemble each other, that they are often considered the same species. By a little attention they can be distinguished from each other. They are both common for a few days in the spring, but neither remain during summer.

Note †127. *F. hyemalis.* The lead-colored snow bird which is seen in such numbers during the winter, does not forsake the State entirely during summer. It breeds in great numbers in the dark beech woods of the Connecticut Western Reserve, and with the approach of cold weather gathers about yards and gardens.

Note †134. *F. linaria.* The lesser red poll. Two winters since a large flock of this very rare bird continued in my garden and the adjacent fields for nearly three months, and finally disappeared at the approach of mild weather. I have never met with the species at any

other time. Some of the males were as richly tinged with carmine, as the most showy of the purple finches.

Note †137. *F. cardinalis.* The cardinal gross-beak. This handsome bird was hardly known on the Western Reserve until within the last three or four years. It has now become common and is a winter resident there.

Note †138. *F. Ludoviciana.* The rose-breasted gross-beak is not only a showy and splendid bird, but one of the most animated songsters. During the spring and early summer months, the vicinities of the cranberry marshes in the northern counties are constantly serenaded by it. We have no bird that sings with so much hilarity. Its notes are not as various as those of the mocking bird, but far surpass them in animation. It sings at all hours of the night as well as during the day. If it were a native of Europe, I am confident its reputation would stand much higher than the nightingale, as it combines so much beauty of plumage with its musical talents.

In the south part of Ohio it is rarely seen, but is a common bird on the shores of Lake Erie and in the adjoining counties.

Note †139. *F. purpurea.* The purple finch. I presume this high-colored finch must occasionally breed in Ohio, as I saw several at Kinsman on the last of June of the present year.

Note †140. *L. curvirostra.* I have not succeeded in obtaining a specimen of the cross-bill, but I believe it is sometimes seen in the county of Ashtabula.

Note † 146. *T. cupido.* The prairie hen is found in considerable numbers in the northwestern parts of our State.

Note †147. *T. canadensis.* I have been informed that a bird answering the description of the Canada grous has been killed on the shores of Lake Erie, but have not been able to obtain a specimen, or even any very authentic account of it.

Note †148. *C. semi-palmatus.* The ringed plover is occasionally seen in the vicinity of Lake Erie and sometimes in the interior of the State.

Note †150. *C. pluvialis.* The golden plover frequently visits us both in its northern and southern migrations.

Note †151. *C. helviticus.* This bird is called the black-bellied kildeer, and is sometimes seen in company with the common species.

Note †152. *S. interpres.* Dr. Sager informs me that the turnstone visits the shores of Lake Erie, and I once saw a specimen taken at the west, but I believe not in the limits of Ohio.

Note †153. *G. Americana.* The sand-hill or whooping crane, the adjutant bird, occasionally visits Ohio. Dr. Ward informs me that two were killed near Roscoe, in Coshocton county in 1837, and the Hon. Calvin Pease also informs me that he once saw a flock of them in Fairfield county in this State.

Note †155. *A. egretta*, or great white heron, has been repeatedly taken in Ohio. Dr. Ward has seen it in the vicinity of Chillicothe, and Dr. Hildreth has furnished me with a specimen from Marietta.

Note †156. *A. discors.* The night heron. Dr. Ward informs me that a fine specimen was taken on the Scioto a few years since.

Note †157. *A. minor.* The brown bittern seems not to be well known at the west; I have, however, specimens both of the old and young, and conclude it breeds on the lake shore, as I saw a number of the half grown young in a marsh at the mouth of the Cuyahoga river on the 1st of July of the present year.

Note †160. *N. longirostris.* The long-billed curlew is an occasional visiter.

Note †161. *N. Hudsonicus.* A specimen of the Esquemaux curlew, taken in the vicinity of Cincinnati, is contained in Dorfeulle's museum. I have one in my own collection presented me by Mr. Hayden from Cleveland.

Note †163. *T. Schinzii.* I succeeded in taking two specimens of this rare sand piper in Poland, in September, 1837.

Note †166. *T. semi-palmatus.* Audubon considers the willet as exclusively confined to the sea coast, notwithstanding Say saw it in Missouri. On the first day of July of the present year, a flock of more than twenty were seen at Cleveland on the shore of Lake Erie, and continued their visits for several subsequent days. I succeeded in taking one, and have no hesitation in classing it among our Ohio birds.

Note †169. *T. Bartramius.* Bartram's tatler. I am informed by Dr. Ward that it is sometimes seen in the Scioto valley.

Note †172. *L. fedoa.* A fine specimen of the marbled goodwit was shot at Youngstown in 1837, which I have prepared in my cabinet. This is the only one I have met with in Ohio.

Note †173. *L. Hudsonica.* Specimens of the Hudson goodwit have been taken near Cincinnati, and one is now in the possession of Mr. Dorfeuille.

Note †177. *R. Virginianus.* This species of rail breeds in our marshes.

Note †178. *R. Carolinus.* One was taken near Fairport, in the county of Geauga, during the spring of 1837.

Note †179. *R. Nove Boracensis.* The yellow-breasted rail, Mr. Robert Buchanan informs me, has been occasionally seen in the vicinity of Cincinnati.

Note †180. *G. chloropus.* The gallinula, though considered a southern bird, sometimes extends its visits as far north as Trumbull county, in Ohio. One was taken during the last spring at Warren, and is so nearly domesticated that it associates with the poultry in a barn yard. Dr. Ward informs me that it has been taken in Coshocton county, and Dr. Sager that it visits Michigan.

Note †181. *P. Wilsonii.* Wilson's phalarope. I once met with a flock of this rare bird on Mill creek, in the township of Boardman, in Trumbull county.

Note †182. *R. Americana.* The avocet. This unique bird has been killed by sportsmen in the vicinity of Cincinnati.

Note †183. *S. aranea.* I am indebted principally to Audubon and Nuttal for my authority in classing this and the other species of Teras

and gulls among our Ohio birds. Further investigation will probably add some other species of these genera to our list.

Note †194. *A. hyperboreus.* The snow goose occasionally visits the shores of Lake Erie in its migrations.

Note †195. *A. albifrons.* The white-fronted goose I insert on the implied authority of Audubon.

Note †196. *A. Canadensis.* I learn from Dr. Ward that the wild goose frequently spends the winter in the Scioto valley, and becomes so tame as to visit the corn fields in pursuit of food.

Note †197. *A. bernicla.* The Brant goose is not unfrequently seen passing over us in the spring of the year, and it is frequently seen on the lake shore during a few days in the spring.

†198. *A. clypeata.* The shoveler duck receives its name from the form of its bill. It occasionally stops for a few days in our waters during spring, while on its way to the remote northern regions.

†199. *A. strepera.* The Gadwell is one of the rarest of the migratory ducks that visits this State. It is sometimes seen about the small lakes in the northern parts of Ohio.

†200. *A. acuta.* The Pintail is an equally rare and still more shy species that sometimes visits our streams and lakes.

†201. *A. boschas.* This beautiful species is the stock from whence was derived our domesticated variety of ducks. It is known as the mallard or green-head. In its native condition it is one of the wildest of the duck family, and its powers of vision are more acute than in any bird with which I am acquainted. It sometimes remains in this State during the whole year.

†202. *A. Americana.* The American Widgeon is an elegant bird, and one of the species that should be domesticated, to enlarge our stock of poultry. It visits our streams in considerable numbers on its way to the north.

†203. *A. obscura.* The dusky or black duck is one of the largest of this family of water birds. Its flesh is delicate and much esteemed for eating. I have no doubt it might be profitably domesticated. It is frequently seen in this State both in the spring and autumn.

†204. *A. sponsa.* The bride, summer or wood duck, is a resident in every part of the State during most of the year. The male exceeds in delicacy, brilliancy and beauty of plumage, any other Ohio bird. This species is naturally tame and is easily domesticated. Its flesh is esteemed for food.

†205. *A. discors.* The blue-winged teal sometimes visits our streams in great numbers. Its flesh is excellent for the table, but its size is too small to make it of much importance.

†206. *A. crecca.* The American or green-winged teal is much more rare than the blue-winged. It is equally esteemed as an eatable bird.

†207. *F. rubida.* The ruddy duck is only an occasional visiter of this State. I have seen only too specimens of it. The flesh is said to be highly valued for the table.

†208. *F. vallisnera.* The noted canvass-back duck has been seen in a few instances in this State, about the lakes and streams in which the wild rice abounds. I know no reason why it might not be advantageously domesticated.

†209. *F. ferina.* The pochard, or red-head, is so nearly allied in color to the canvass-back that they are often mistaken, one for the other. It is a more frequent visiter of our borders, and is highly valued for the table.

†210. *F. marilla.* The blue-bill is often seen in the spring and autumn, and is the most tame of any of this family. Its flesh is not very palatable, but would, without doubt, improve, if reared among our domestic poultry.

†211. *F. rufitorques.* The ring-neck is a visiter early in the spring. Its flesh is hardly eatable.

†212. *F. clangula.* The golden-eye is an extremely rare species.

†213. *F. albeola.* This harmless and neat little species is very abundant during the fall and spring, and though of no value for eating, is killed in great numbers by boys and idle gunners merely because it can be easily approached.

†214. *M. merganser.* The goosander is the largest of the duck family that visits our waters. It frequently remains even in the northern parts of the State during the whole of winter, and I believe occasionally breeds there, as I once observed an old one with her young on the shore of Lake Erie in the month of January 1810. There is so great a difference in the appearance of the male and female, that they are often taken for different species.

†215. *M. cuculatus.* The hooded merganser is one of the earliest visiters that approaches us from the south with the first appearance of spring. Its plumage is showy and handsome.

†216. *M. serrator.* This species of merganser is more beautiful. It is the last of the migratory species of duck to visit us in spring, and makes but a short tarry. Like the other species of the mergansers, its flesh is not eatable.

†217. *C. musicus.* The swan is not unfrequently seen both on the Ohio and the shores of Lake Erie during spring and fall.

†218. *P. onocrotalus.* The pelican is an occasional visiter.

†219. *P. cristatus.* I have seen within our limits all the species of this family enumerated in this catalogue.

†223. *C. glacialis.* The loon, or great northern diver, frequently visits our rivers during the spring. It seems to rise with great difficulty when it attempts its flights from the water, but when on land its efforts are entirely unsuccessful.

I have known several instances during the last fifteen years when they have been picked up on land a short time after a heavy storm, having probably been driven either from the Ohio river or the lake by the violence of the wind.

CLASS III. REPTILES.

Note ||1. *C. clausa.* The box or lock tortise is rather a rare species, but is occasionally found in every part of Ohio. Its favorite places of resort are dry and sandy hills.

Note ||2. *E. picta*, is a common species in the western waters. It is usually not as highly colored on its marginal plates, as in the figure of Dr. Holbrook in his work on American reptiles.

Note ||3. *E. punctata.* The small spotted tortise I believe is a rare visiter, as I have never met with it except in one instance.

Note ||4. *E. megacephala.* This species is equally abundant with the picta, with which it is usually associated, and a superficial observer would consider them one species. They are however very distinctly marked.

Note ||5. *E. geographica.* Lesuer describes this species as an inhabitant of Lake Erie. It must be comparatively rare, as I have never been able to meet with it in any of my excursions. A fine specimen is exhibited in the Cincinnati museum.

Note ||6. *E. odorata.* This species is found in the northern waters of this State, but is generally mistaken for the young of the following species:

Note ||7. *C. serpentina.* It is universally known as the *snapping turtle, the mud turtle, or the land turtle.*

Note ||8. *T. ferox.* The soft-shelled tortise is very abundant in all our streams, both of the Ohio river and of Lake Erie. In calm weather during summer, great numbers may be seen floating near the surface of the water, and I have almost universally observed at such times, several of the black bass to be following closely in their trains. What attracts this coy fish about them I could never ascertain.

Note ||10. *S. quinquelineatus* and *S. lateralis* were shown to me by Mr. Dorfeuille, as inhabitants of Ohio.

Note ||12. *A. undulata.* He also showed me a prepared specimen, which from a hasty observation, I conclude must be this animal. It was taken in the Miami valley.

Note ||13. *C. constrictor.* The large black snake is evidently increasing as our state becomes more cleared and cultivated.

Note ||14. *C. sirtalis.* This species is well known as *the garter snake.* Its numbers are rapidly decreasing as it is universally destroyed by man, and is eaten by hawks, owls, swine, and in some instances by fowls, ducks and turkies.

Note ||15. *C. punctatus.* It is occasionally found in this State, though not abundant. Harlan has described it, and a fine figure of it may be seen in Holbrook's Herpitology.

Note ||16. *C. saurita.* This delicately striped snake of our country is generally considered a variety of the garter snake; the former is more active in its movements, vivid in its colors and delicate in its form. It usually seeks the most retired woods for its residence.

Note ||17. *C. vernalis.* The green snake is an occasional resident in every part of the State, but not very common.

Note ||18. *C. sipedon*. Several species of coluber are blended under the common name of *water snake*. The C. sipedon is well marked and very distinct from the others. The C. porcatus and probably one or two undescribed species, inhabit the shores of our rivers and creeks and associate with it.

Note ||19. *C. coccinænus*. A specimen labeled with this name, and said to have been taken in Ohio, was shown me by Mr. Dorfeuille.

Note ||21. *C. obsoletus*. During the earliest settlements of this State, a slim, inactive black snake was frequently seen, differing essentially, in its form and habits, from the C. constrictor now common with us. I have not seen the first mentioned species for several years, till the present season. An imperfect and mutilated specimen recently obtained, presents the characters given to the obsoletus by Say, which he describes as an inhabitant of Missouri.

We have several other species of coluber which have either not been described by authors, or their descriptions are not applicable to our specimens.

Note ||23. *H. platirkinos*. The flat-headed or hissing adder is said to be an inhabitant of the northwestern parts of Ohio. I have not been able to procure a specimen.

Note ||24. *H. niger*. In the year 1810 I killed a specimen of this uncouth looking serpent at Legionville, Gen. Wayne's old encampment, near the present site of Economy, on the Ohio river. I learn that it has been killed on the Ohio hills, within the limits of our State, and as Dr. Troost describes it as an inhabitant of Tennessee, it is probably entitled to a place in our catalogue.

Note ||25. *T. contortix*, of Holbrook, Cenchrus mokeson of Daud. Red adder and copper-head of common language. Holbrook says, "as yet I have no evidence of its existence in the valley of the Mississippi; its place is there probably supplied by the Toxicophis atro-fuscus, of Troost, to which its habits are very similar." The copper-head is found on the waters of the Mahoning, Big Beaver, and Muskingum, and as they are, in truth, tributaries to the Mississippi, we must not consider this snake as entirely excluded from the valley of that river. A few years since it was very common, and during the present summer a considerable number have been killed by farmers while haying and harvesting, and more by the hands employed in excavating the Ohio and Pennsylvania Canal. I have examined two, and find them to agree in every particular with his full and clear description of the T. contortix, as well as with his splendid figure.

It is not improbable that the Toxicophis atro-fuscus is also a native of the same locality, for the people speak of a *black copper-head*, which they consider even more venomous than the red variety.

Note ||26. *C. durissus*. The yellow or banded rattle-snake was formerly very abundant in Ohio; it is now rarely seen. There were some varieties of color, owing to sex, age, and the season of the year, but these were well recognized by the first settlers of the country, as mere varities of one species, and known under one of the above common names. This snake was also equally well distinguished from

another species known under the popular name of ***Massasaugua***, or *black rattle-snake*.

This last I was disposed to consider a variety of the miliarius, but on examination I entertain doubts whether the snake known at the north under the popular name of Massasaugua, is not a species distinct from the C. miliarius of the southern States. Dr. Holbrook considers them the same. On comparing my specimen with his figure, I find mine to be destitute of the high coloring on the back; it is universally dark-fuscus, dotted with black spots on the side, with a row of oblong-transverse black spots on the back; the head is sub-oval rather than triangular, and comparatively small; length of head, 2 inches 2 lines; body, 22 inches; tail, 2 inches; rattles, 6; sub-caudal plates, 29; first and last divided.‡

Note ||28. *M. Alleghaniensis*. The alligator of the fishermen is found in all the tributaries of the Ohio, but not in those of Lake Erie.

Note ||29. *M. lateralis*. The Proteus is taken very often in the lake streams, and sometimes in the tributaries of the Ohio.

Note ||46. *R. sylvatica*. The wood-frog is said, by authors, to be confined to the Atlantic States in its range; it is however nearly impossible to move in our Ohio woods during summer, without stepping on them, they are so abundant.

CLASS IV. FISHES.

Note *†1. *B. flavescens*. The yellow perch is found in Lake Erie and most of the small lakes in the northern parts of the State, but did not exist in the waters of the Ohio until it found its way into them through the midium of the Ohio canal. It is rapidly increasing and will soon supply all the tributaries of that river. As soon as the Pennsylvania and Ohio canal shall be completed, a new and more convenient thorough-fare for this fish to extend its migration will be opened, and as it abounds in the small lakes connected with feeders of that canal on the summit-level, it will, without doubt, soon stock all the northern branches of the Ohio.

*†2. *L. Americana*. The *salmon of the Ohio*, *pike of the lake*, *American sandre of the north-western voyageurs*, and *Perca salmonis* of Raf. It is one of the most valuable fishes for the table found in the western waters, and sells readily at a high price in the markets of the towns on the banks of the Ohio. Those taken in Lake Erie are less esteemed.

Two varieties are discoverable among them, which I suppose to be a mere sexual difference, though many fishermen, and market people consider them distinct species, one of which they call the brown salmon, the other yellow.

It is still found in such quantities about the Maumee river, as to induce fishermen to take it as an article of commerce. Its numbers

‡ If it prove to be a distinct species, as I have little doubt it will, I propose to designate it as the CROTALUS MASSASAUGUS.

have, however, been so rapidly reduced of late years that the pursuit will soon be abandoned.

During the hot weather of summer it retires to the deep and cool water of the lakes, and in the streams seeks the inlets of the coldest springs, near which it takes up its abode, concealed by weeds or grass. It bites readily at a baited hook.

*†3. *P. valgaris.* Sun-fish, or roach. Rafenesque has described several species under the generic name of *Icthelis.* I have not satisfied myself whether his arrangement is correct, and have, therefore, retained Cuvier's name.

Varieties, or perhaps distinct species, are abundant in all the western waters.

*†4. *C. ænea.* The rock-bass is also common, but is usually confounded with the preceding species by those who are unacquainted with the scientific distinctions.

*†5. *C. Storeria.* The grass-bass of the lake, the bank-lick bass of the Cincinnati market, was first sent to me from Cleveland by Mr. Charles Pease, and a figure and description with the above specific name was forwarded by me to the Boston Society of Natural Science, for publication. I gave it this specific name as a token of respect to Dr. D. Humphrey Storer, one of its members.‡

This fish, in some particulars, agrees with Rafenesque's description of the *Calliurus punctulatusa*, but the form of the dorsal-fins and the number of the rays are so different they cannot be the same species. In his, the thoracic *fin* is five-rayed without a spine. This has *six* rays in the thoracic fin, and the anterior ray is strongly and prominently spinous—it is a rare species and should, perhaps, be arranged under the genus Centrarchus.

* †6. *C. Fasciata* and *C. Ohïoensis.* The black-bass of the Lake, and of the Ohio river. Lesuer has described them as distinct species. I have no doubt they are specifically identical. They differ in form and color at different seasons and in different localities, and even the same individual will change its color repeatedly in a short space of time, if confined in a vessel of water.

Rafenesque has described that from the Ohio under the generic name of *Lepomis*, and taken these changings of color as a distinction upon which he has founded several of his species. His Lepomis notata is no other than the young of the common black bass. Their appearance varies at different ages.

This fish readily bites at a hook and is valued as an article of food.

*†8. *C. minima.* Lesuer describes this as an inhabitant of Lake Erie. I am suspicious it is only the young of the preceding species, as I have never been able to find it, though I have searched repeatedly in the lake and its tributaries.

*†9. *G. inconstans.* This unique species of *stickle-back,* I dis-

‡I have learned from Dr. Storer, since this report went to press, that Dr. Cuvier had previously described this fish. Not having Dr. S.'s communication at hand, I am unable to give the name applied by that author; but it must of course take the preference of mine.

coved in a small stream in the village of Poland, Trumbull county; and have furnished the Boston Academy with a figure and description of it for publication.

*†10. *S. grisea*. The white perch of the Ohio river is esteemed as one of the best fishes for the table, and, therefore, fetches a high price in market. It differs entirely from a fish taken in Lake Erie, and known by the fishermen under the same name, which belongs to the family percoides. The Ohio species has been described by Rafenesque as the *amblodon grunniens*.

*†11. *S. oscula*. The *sheeps-head* of Lake Erie resembles, in general appearance, the S. grisea; but I believe it to be a distinct species. It is not considered as eatable.

*†12. *E. caprodes*. The etheostoma is a new genus created by Rafenesque to receive several species of small fishes of our western waters, known by the vulgar name of Hog-fishes from the shape of their mouths and noses. The E. caprodes is common and furnishes the boys with amusement in taking them.

*†14. *E. maculata*. The spotted etheostoma exceeds in beauty the speckled trout or any other fish of our western streams. It is very rare, and I have met with it only in two instances. I have prepared a figure and description for publication.

*†15. *E. variata*. The variegated etheostoma is another new species discovered by myself in the Mahoning river. It is little inferior in beauty to the preceding species. I am indebted to Mr. Charles Pease for a specimen of the same species taken in the Cuyahoga.

*†16. *C. velifer*. Carp of the Ohio. It is evident from the figure and description of the C. cyprinus of Lesuer, that ours is a distinct species, which Rafenesque has very correctly described under the above name. It is common in the Cincinnati market, but is not much esteemed for eating.

*†17. *C. aureolus*. The mullet of the lake is confined to the waters of Lake Erie, and supplies the place of the C. Duquesnii of the Ohio. Like most of the members of this genus, it is worth but little as an article of food.

*†18. *C. elongatus*. The Missouri sucker, and the black-horse and black-buffalo of the Cincinnati market. Lesuer's figure of the C. elongatus in the journal of the Academy of Natural Sciences of Philadelphia, has so little resemblance to this fish, that I drew a figure of it and prepared a description under the name of *C. fusiformis*, before I had any suspicions that we were both aiming at one species. The number of rays in the several fins and the form of the dorsal led me at length to arrive at this conclusion. He had seen only a dried skin. It is said to be a good fish for the table, and commands a high price and rapid sale in the Cincinnati market.

*†19. *C. Duquesnii*. The white sucker is known by every one familiar with the fish of the Ohio.

*†20. *C. erythurus*. The red-horse is another common species in our markets, but is not highly esteemed.

*†21. *C. bubalus*. The buffalo and red-horse suckers are many

times mistaken for each other, though their specific characters are very distinctly marked. The buffalo is a tolerably good article of food. The young is called the buffalo pack.

*†22. *C. gracilis.* I have occasionally met with this species in market, from the Big Miami, and in a few instances in small brooks in the north part of Ohio. It is distinguished by the minuteness of the scales on the anterior part of the body, and as the scales approach the caudal fin they increase to a medium size.

*†23. *C. melanopsis.* The spotted sucker of the Cincinnati markets. Rafenesque's description does not well apply to our fish, but I have retained his name. The form of this species is so much like that of the bass that people unacquainted with it sometimes purchase it with the expectation that it is a good article for food. They do not, however, often repeat the experiment, for it is one of the least valuable of this indifferent family.

*†24. *C. nigrans* of Lesuer—*C. xanthopus* of Rafenesque. The mud-sucker is found in every stream of any size in Ohio, but is of little value. It is frequently called the mullet in the Cincinnati market.

*†25. *E. Lesurianum.* The rough-nosed sucker of the northern streams, is probably the fish which both Lesuer and Rafenesque had in view when they wrote their descriptions, one of the Cyprinus maxillingua, the other of the Exoglossum Lesurianum. During the spring and early months of summer, its nose and forehead are studded with deciduous spines or tuburcles, which drop off after the spawning season has passed, and the surface then becomes smooth. Under these different conditions it might be mistaken for two distinct species. It bites readily at the hook, and is often used for food in those parts of the State that are only supplied with small streams of water. In such localities it is the most abundant.

*†26. *H. macropterum.* A small fish answering to Rafenesque's description of his stone-toter, visits the small streams for about two months in the spring, when it may be seen in great numbers forming excavations or beds on the ripples. It soon disappears and is not to be met with again during the remainder of the year. I presume it migrates to the Ohio.

*†27. *M. dinemus, &c.* Persons who have curiosity to investigate the interesting but obscure family of the *chubs, minnows and shiners,* of our Ohio waters, will find them very accurately described by Rafenesque, in his work "*On the Fishes of the Ohio.*"

*†30. *L. elongatus.* The red-bellied minnow of the lake differs by its great length, elongated and pike-formed mouth, from the L. erythrograster. It is a well marked and distinct species, the existance of which was first pointed out to me by an experienced fisherman of Lake Erie, who procured me two specimens of it with several of the erythrograster; but they were destroyed before I had an opportunity to make a drawing or write a description of them. I hope however to obtain more specimens.

*†36. *R. crysoleucas.* I have some doubts whether this is the true

gold shiner of the eastern states, or a new species. I preferred to retain this name till the point could be more satisfactorily settled.

*†38. *P. promelas*. The fat-headed chub was only once met with by Rafenesque, and that was a specimen taken in Kentucky. I had the good fortune, during the last autumn, not only to take three specimens in a small creek in Poland, but to observe their habits. They had formed beds beneath the ends of logs and stones in deep water, and were watching their domicils with great care. If a large fish approached, they would attack them with great energy, and generally with success. Though allied to the minnows in its external character, it has the habits of the sun-fish.

*†39. *H. limi*. This new species of mud-minnow, was discovered deeply imbedded in soft mud, by some workmen engaged in ditching a swamp. It is more tenacious of life than any fish with which I am acquainted.

*†40. *E. estor*. The muskallonge is found exclusively in the waters of Lake Erie, though a few years since one was taken in the Ohio canal near Massillon, having strayed thus far from its usual haunts. It is one of the best fish for eating produced by the western waters. Lesuer first described it as a distinct species, but it is still confounded by many people with the common pike, (the E. reticulatus,) though the difference between the two is understood by the fishermen as well as men of science.

*†41. *E. reticulatus*. The Pike is common both to the waters of the lake and the Ohio. As the names pike, pickerel, and muskallonge are used rather indiscriminately, the *E. estor* and *reticulatus*, and the *Lucoperca Americana* are very likely to be mistaken one for the other. They are distinct species. The *pike* is less esteemed for food than the *muskallonge*, and I believe in the Cincinnati market, does not rank above the *salmon* or *pickerel*.

*†42. *E. niger*. It is somewhat doubtful whether this is the young of the E. reticulatus, or a distinct species. The bayous about the lake and the Cuyahoga river, abound with them, and the fishermen inform me that they never attain any considerable size.

*†43. *P. cerulescens*. The blue catfish is common to the Ohio and the lake waters, and is universally known.

*†44. *P. cupreus*. The yellow catfish, I have only seen in the Cincinnati market, where it is comparatively rare. Its yellow copper color serves to distinguish it from the other members of this family.

*†45. *P. pallidus*. The channel catfish is very common in the Ohio river at Cincinnati. It is easily distinguished by its forked tail and maculated body.

*†46. *P. nebulosus*. Mud catfish. This species is occasionally seen in the Cincinnati markets, and is readily known by the scarified and clouded appearance of the skin.

*†47. *P. xanthocephalus*. I have applied this name of Rafenesque to the small black bull-head of the northern streams and lakes. His description is very imperfect.

"*The inhabitant of the waters*," says Griffith in Cuvier's Animal

Kingdom, "*knows no attachment, has no language, no affection; feelings of conjugality and paternity are not acknowledged by him.*"

I have watched for hours together the female of this species, while she was leading about, in the most maternal manner, her brood of dusky fry. No hen is more anxious for the safety of her young flock, nor more ready to protect them from danger, than this finney mother, which this author says, "knows no attachment." She will instantly attack, with great violence, every fish, tortoise or frog that ventures within her precincts, nor will she give over the contest till it is driven far away, when she will rapidly return and carefully examine to see if her charge are all safe.

*†48. *N. flavus.* This rare fish is occasionally found beneath stones in the Mahoning river, and is known as the young catfish by boys and fishermen; it is however a full grown and distinct species. I doubt the propriety of constituting it a separate genus, as has been done by Rafenesque. The rudiments of an adipose fin are observable on the back.

*†49. *S. manycash.* This name was applied to the Mackinaw trout, I believe, by Pennant. Dr. Mitchell subsequently described it as the S. anythistus. A few stragglers are occasionally taken in Lake Erie.

*†50. *S fontinalis.* The speckled trout are to be found in Ohio in only two streams, a small creek in Ashtabula county, and a branch of the Chagrin river, in Geauga county. They also exist in the head waters of the Allegheny, in Pennsylvania, but never run down into the Ohio.

*†51. *C. artedia.* The lake shad is a rare fish. It is said to be of an excellent quality for eating. From its intimate connection with the *salmon* family, such would be inferred to be the fact.

*†52. *C. albus.* The white fish, though frequently taken in the lake within the limits of Ohio, is not found there in numbers sufficient to render them of much value.

*†53. *P. chrysochloris.* The gold shad or skip-jack is a very rare fish that has a slight resemblance to a mackerel. I have seen only two specimens in the Cincinnati market. It is said to be a fine fish for the table.

*†54. *C. ellipticus.* The hickory, or gizzard shad is frequently exposed for sale in market, but not very highly esteemed.' The common names are applied to this fish, which Rafenesque says are used to designate his Dorosoma notata; but the size of the two, form of the dorsal fins, and other characters, hardly fail to distinguish them as different fish.

*†55. *H. clodalus.* I have admitted three species of this genus into my catalogue. Two belonging to the Ohio, and one to Lake Erie. I believe that there is still a different species in the lake, and perhaps several more in the Ohio. They are familiarly known as the toothed herrings by the Cincinnati fishermen, and as the moon-eyes by those who fish in Lake Erie. No one of this genus of fishes taken in our western waters is much esteemed for food.

*†58. *A. calva.* The dog-fish is found in Lake Erie, where it is

frequently called by the fishermen, "the Lake Lawyer." It is distinguished by its ferocious looks and voracious habits. The flesh is rank, tough and not eatable. To the anglers it is a troublesome nuisance, by taking their bait and often breaking their hooks and lines, which it can readily do by means of its large teeth and long jaws. Linnæus described a species of this genus, as inhabiting the waters of Carolina. His characters agree essentially with those of this Lake fish so far as I have compared them, except in the relative size of the pectoral and ventral fins; still I believe they are specifically identical. I have not yet had an opportunity to examine the peculiar anatomical structure which he says the southern fish possess.

*†59. *L. platostomus.* . The duck-bill gar, Rafenesque describes as an inhabitant of the Scioto. I saw a specimen from that river six years since, that, from recollection, I presume was this species, but I have not since met with it.

*†60. *L. ferox.* The alligator gar is not a common inhabitant of the waters of the Ohio; a specimen is however to be seen in the Cincinnati museum, said to have been taken in this river within the bounds of our State.

*†61. *L. oxyurus.* The common gar is found in most of the larger tributaries of the Ohio, and a species also exists in Lake Erie; but I have not yet been able to ascertain whether it is the oxyurus or not.

This genus belongs to the Saurian family of fishes, and is distinguished by the peculiar organization of the respiratory organs.

*†62. *L. maculosa.* The gadus maculosas of Lesuer, or eel-pout of the fisherman, inhabits Lake Erie. Its flesh, though not highly esteemed, is eatable. This and the dog-fish are frequently confounded together, though they have only a slight resemblance in their general appearance, and still less in their essential scientific characters.

*†63. *A. laticauda.* Rafenesque has made several species of the western eels. I believe this and the following species in the catalogue are distinct, and probably different from those of the eastern waters. Further observation however is necessary to decide the point with certainty.

They run up the Mahoning river from the Ohio, as far as Warren, in Trumbull county, but are never found in any of the lake streams.—They may at some future day find the way there through either the Welland, the New-York, the Ohio, or the Ohio and Pennsylvania Canals, or perhaps some of the more western public improvements.

*†65. *A. rubicundus.* I have been able to discover only this species of sturgeon in Lake Erie, though perhaps others may exist. Its flesh is frequently eaten and is esteemed by the fishermen.

*†66. *A. maculosus.* The spotted sturgeon is described by Lesuer as an inhabitant of the Ohio. I have never seen it.

*†67. *A. Ohioensis.* The large Ohio sturgeon of Rafenesque is frequently exposed for sale in the markets of Cincinnati, and as it is readily bought up, I conclude it is esteemed good for eating.

*†68. *A. platorynchus.* The shovel-nose sturgeon is equally com-

mon with the preceding in the waters of the Ohio. The form of the nose having a strong resemblance to an Irish shovel, has given the common name to this species.

*†69. *P. edentula*. The paddle-nose fish differs essentially from the shovel-nose sturgeon, though they are sometimes mistaken for each other. It is found in the Ohio and the Muskingum rivers.

*†70. *P. nigrum*. The small black lamprey eel is described by Rafenesque as an inhabitant of our western waters. I have not succeeded in procuring a specimen. It is possible he may have had the ammocetes in view when he made out his description.

*†71. *The silvery lamprey*. This species I obtained from the Big Miami. I learn that Lesuer once described, in a pamphlet, a species belonging to our western waters, but having never met with the publication, I am uncertain whether or not it is the same species. If it should prove to be his I will willingly yield it to him. I give it the above name from the silvery appearance of its sides and abdomen.

*†72. *A. bicolor*. Lesuer. The blind lamprey is rarely met with in our waters. I once obtained three specimens in the Mahoning river, the only instance in which I have discovered it. Leseur described a specimen taken in Connecticut river, but I have some doubts whether that of the Mahoning is not a different species. Its character appears to be different. Where we should expect to find eyes, we meet with only a slight depression of the surface, but no eyes.

CLASS V. TESTACEA.

** *Note.*—I have adopted with a few exceptions, the arrangement of Mr. Lea, so far as the bivalves are concerned. His synopsis is very ingeniously based on scientific principles, and contains fewer errors than the works of any author who has attempted to settle the numerous and perplexing synonyms, that have encumbered the family of Naiades.

**3. *U. anodontoides* has been repeatedly found in the streams near Cincinnati during the present season. The specimens are frequently rayed and more beautiful than Mr. Lea's figure in the Trans. of the Amer. Philos. Society.

**6. *U. canelus*. It is questionable whether this is any other than an old and strongly marked variety of the *U. phaseolus*.

**12. *U. Cooperianus*. Some naturalists have considered this as only a variety of the U. pustulatus. I have obtained full suites from the youngest to the oldest, and find them marked with one uniform character. It is doubtless a true species.

**15. *U. crassus*. Any one who has compared the ponderous shell of the species found in the Ohio, and the two Miamies, and sometimes known as the U. ellipticus of Barns, with Mr. Say's plate of the U. crassus in Nick. Encyclopedia, could hardly fail to recognize the perfect resemblance between them. His description applies to no other shell.

**17. *U. declivis*. A shell answering Say's description of the southern shell of this name, is found in the Big Walnut creek, and other tributaries of the Scioto river, and in some portions of the Ohio canal.

**19. *U. donaciformis* is probably only the female of the U. zigzag of Lea. The varieties of form occasioned by a difference of sexes, in several members of this family of shells, occasioned until recently much per-

plexity among naturalists, and introduced into notice, as new species, a number that were only sexual varieties.

All writers upon the anatomy and physiology of that mollusci, had considered that portion of them embraced by the family of naiades of Lamark, which includes the genus margarita of Lea, as being hermaphrodite. A course of dissections and observations upon the Unioines, instituted by me several years since, led me to believe that they are androgynous, and by pursuing the investigation I am enabled to decide, with many species, to which sex an individual belongs, by merely inspecting the contour of the shell. My views upon this subject were published in the twenty-sixth volume of Silliman's Journal of Science, and though they were opposed to those of Flemming, Sir Everard Homes, and other European naturalists, as well as of Say and Rafenesque in this country, I believe they will stand the test of the closest scrutiny. I am happy to find they are fully sustained by Mr. Lea, in his last memoir, published in Transactions of the Amer. Philos. Society.

**34. *U. Kirtlandianus* is probably only a compressed variety of the U. subrotundus. This is owing to locality. By examining the specimens from the Scioto, Tuscarawas and Mahoning, there will be found a regular gradation from the one species to the other; those from the Tuscarawas occupying a middle station between the extremes; those from the Scioto being globular, heavy and fully developed, constituting the *subrotundus*; while those from the Mahoning are compressed and comparatively thin, forming the *Kirtlandianus*.

**41. *U. multipliratus*. This rare and interesting shell is found in the Little Miami. Some conchologists are disposed to consider it as only a variety of the U. plicatus, or the undulatus, produced by locality. In this view they are incorrect; for I have myself taken all three of the species, fully developed, from the same vicinity in that stream.

**46. *U. occidens*. It is impossible, in the present state of our knowledge of this branch of science, to draw with much precision the lines of specific distinction between the members of a certain group of shells embracing the U. ovatus, ventricosus, occidens, subovatus, &c.

**47. *U. orbiculatus*. Dr. Hildreth described a strongly developed female shell. His description has the precedence, and his name, therefore, should be adopted. I have seen the shell which he described in his cabinet.

**51. *U. perplexus*. The perplexus, Rangianus, and Capsæforinus, form another group which it is somewhat difficult to separate into species. The first and second are certainly distinct: they occur together in the same localities in the Scioto and Ohio—the last is more doubtful.

**52. *U. personatus*. The pileus of Lea, and the personatus of Say, belong probably to one species—the former being the male, the latter the female.

**55. *U. plicatus*. From some cause, to me unknown, the plicatus and undulatus have exchanged names in many cabinets in the United States. The plicatus described by Say was a shell procured by Lesuer in Lake Erie. The species known in our cabinets by this name is never found in the lake or its tributaries; but that which we commonly label as the undulatus is a common lake shell: therefore, the latter must have been the shell which Mr. Say had in view. Barns' figure is as good a representation of one as of the other, but very indifferent of either. The misnamed plicatus is to be met with only in the Ohio or its tributaries.

**63. *U. Schoolcraftensis.* Further observation will probably decide this shell to be a more compressed and angular variety of the U. pustulosus, owing to the influence of locality. It is found in the tributaries of the chain of lakes in which most of the shells are thinner and more compressed than those of more southern waters.

**79. *M. calceola.* From some examinations which I have made of the animals of the sub-genus margaritana, I believe they differ more essentially from those of the Unioines than do the structure of their shells. The character of the animal of the Calceola, as well as of the teeth, sustain Mr. Lea in transferring it from the Unioines to this sub-genus.

**82. *M. rugosa.* Every individual of this species found in Mill creek, in the township of Boardman, Trumbull county, contains a number of pearls, in some instances amounting to twenty or thirty, and sometimes attaining to the size of a common pea. The stream is muddy and sluggish, and, though it contains considerable numbers of this species, appears to render them sickly.

These pearly concretions frequently are firmly attached to the nacre of the shell, but more commonly are loose in different parts of the mouth and branchia. In one instance I found a cluster of them among the fibres of the large transverse muscle.

** *Anodonta.* Our Ohio streams and lakes abound with a number of distinctly marked species of this sub genus, and with others that vary with only shades of difference. It is impossible at present to arrange them satisfactorily into species.

**101 *H. diodonta.* This rare helix is confined to the northern parts of the State.

**119 *H multilineata*, is one of the handsomest species of American helices. Its habits are peculiar. Wet marshes are its principal resort, where, during summer, it may be seen climbing about on weeds and spears of grass, apparently endeavoring to avoid the water collected beneath it. At the approach of winter, it retreats to the tops of the carex bogs, where several dozen may be found collected together in a torpid state, with the mouth of their shells closed with an artificial operculum. They usually form a shallow excavation on the bog, concealed beneath the tufts of dead grass.

**130. *Heleciana.* A small species of this genus is occasionally found on the hills adjacent to the Ohio river, but I have been unable to satisfy myself whether it is the one described by Mr. Say, or not.

**132. *P. exigua* is the smallest species of terrestrial shell with which I am acquainted. It is scarcely distinguishable with the naked eye, but examined through a microscope, presents a neat and beautiful appearance. I believe it is found in this State only in its northern portions.

**145. *P. parvus.* A minute species is found in the cranberry marshes of the north, that answers in part to Say's descriptions. It is found adhering to sticks and pieces of bark that have fallen into the water.

**148. *P. elongata.* An elongated species of physa, is sometimes seen in stagnant pools in the northern parts of the State, supposed to be the species described under this name by Mr. Say. It is distinguished by its gracefully elongated form, dark shining color, and the rapidity of its motions.

**150. *P. Sayii.* The Hon. Benjamin Tappan has prepared figures and descriptions of several new shells. A new physa is among the number, and I learn from him that he has given it this name.

**151. *L. catascopius.* The shell described by Mr. Say under this name, is an inhabitant of the eastern waters. I have recently met with specimens in Portage county, in this State, that agreed so minutely with it, that I have applied this specific name to them.

**156. *L. stagnalis.* The shell to which this name was applied by Dr. Hildreth, was found by myself in Congress Lake, in Stark county, and I have since met with it in some lagoons on the shores of Lake Erie and the Detroit river. It is the largest of our fluviatile univalves, and so perfectly agrees in every character with its European analogue, that I consider Dr. Hildreth correct in applying to it the same name.

**161. *M. isogonica.* I have never met with this rare shell except in the Scioto river near Chillicothe.

**163. *A. prærosa.* In addition to this species, I am informed by several naturalists at Cincinnati, that two other well marked species have been discovered in the Ohio near that city.

**164. *V. sincera*, is very common in the marshes about the Detroit river in Michigan. I have recently found a few specimens at Cleveland in this State.

**165. *V. tricarinata*, inhabits the Munson Lake in Geauga county.

**167. *P. granosa.* I found this shell in company with the Valvata tricarinata adhering to a species of potomogeton in the Munson Lake.

**168. *P. heterostropha.* I applied this name to an undescribed sinistral species of Paludina that inhabits the Mahoning river and several small streams in Trumbull county.

**169. *P. microstoma.* An undescribed species of Paludina, found frequently associated with the P. decisa, and distinguished by its elongated spine and small mouth. To this list should also be added the Paludina ponderosa of Say. I have recently been furnished with it by Mr. Anthony of Cincinnati, who obtained it in the Ohio near that city.

PROF. LOCKE'S

GEOLOGICAL REPORT,

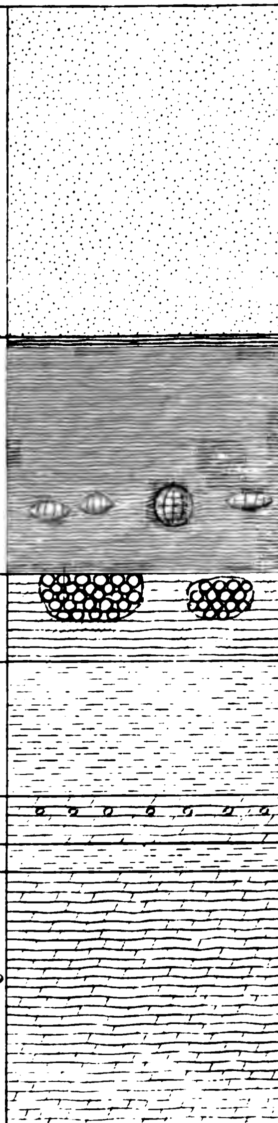
COMMUNICATED BY THE GOVERNOR

TO THE GENERAL ASSEMBLY OF OHIO.

DECEMBER, 1838.

No. 1

SECTION *Showing the strata of rocks in S. W. part of Ohio*
BY JOHN LOCKE.



NO	Feet		
VII	347		Fine grained Sandstone *Comes to the surface in E. part of* ADAMS CO.
VI	251		Bituminous Slate *E. part of* ADAMS CO. Sulphur Licks
V	89		Cliff Limestone *including basins of Iron ore* (*Middle part of* ADAMS CO)
IV	138		Marle (*Middle part of* ADAMS CO)
III	48		Flinty Limestone (*Middle part of* ADAMS CO)
II	24		Marle (*Middle part of* ADAMS CO)
I	1000?		Blue Limestone *W. part of* ADAMS, BROWN, CLERMONT, HAMILTON, BUTLER, WARREN, MONTGOMERY, PREBLE &c.
Total	1897		

Doolittle & Munson

DR. LOCKE'S REPORT.

PROF. MATHER,
Principal Geologist of the State of Ohio.

As the geological reports are intended, in part at least, for the distribution of useful information among the people, it will be necessary to introduce occasionally, though briefly as possible, such elementary explanations as will enable them to understand the subject discussed.

The region which you have assigned to me for examination, viz: The "southwestern quarter of the State of Ohio," is chiefly a part of the "great limestone deposite," but extends also through the slate, and "Waverly sandstone." Such an examination of all the varieties of our limestone, extending through more than a thousand feet of perpendicular thickness, may well be prefaced with a few remarks on the nature and uses of common limestone, or CARBONATE of lime.

Of the nature and uses of Common Limestone or Carbonate of Lime.

Common limestone is composed essentially of fixed air 44 parts, and pure lime 56 parts; making 100 parts. The fixed air is now commonly called carbonic acid, and is the same as that which is produced by burning charcoal, by the fermentation of liquors, and often by the earth itself, from which it flows into wells and caverns, where it frequently destroys the life of persons who incautiously descend. The miners call it "choke damp." This fixed air or carbonic acid is driven off from the lime of limestone, by adding any strong acid, even vinegar will produce the effect in a moderate degree, and as the fixed air escapes through the liqud applied, it forms numerous minute bubbles, which, as they break rapidly make a singing noise, and give the appearance of boiling. This action is called effervescence, and affords a convenient test to determine whether a given specimen of stone be limestone or not. By the rapidity of the boiling a very correct general estimate of the purity of the limestone may be formed. For this use an ounce vial full of the muriatic acid, to be applied in the quantity of a drop or a part of a drop at a time, is very convenient. The fixed air is also driven off by heating the limestone to redness and continuing the heat for some time. This is what is actually done in the burning of lime in the lime-kiln, by which operation the stone, if pure, looses near half of its weight, 44 parts out of 100, and becomes pure lime, or unslaked burnt lime. The stream of fixed

air, flowing from the lime-kiln, has some times suffocated those who were carelessly sleeping near.

Hydrate of lime—slaked, or "slacked lime."—The most noted property of burnt unslaked lime is, its rapid and greedy absorption of water, by which it evolves heat, increases in bulk and weight, and falls into a powder, which is called "slacked lime." In slaking, 28 parts of lime combine with 9 parts by weight of water, which becomes solid and dry as stone, loosing all the properties of moisture, and cannot be dried out or separated again unless by a red heat. Owing to the evaporation caused by the heat, it requires more than the above proportion of water to slack lime. "Slacked lime" is a white, dry, soft, light powder, caustic to the taste, and caustic to animal and vegetable substances, which it dissolves. It is partially soluble in water, and forms by solution "*lime-water*," which has the taste and caustic properties of the lime itself. Mixed with a moderate quantity of water, it forms a plastic or pasty mass, which will dry into a cake moderately hard; or if sand be added, it will form mortar, which on drying, becomes a hard cement, used in building. If unslaked lime be exposed to the air, it will absorb moisture and fixed air from it, fall gradually to powder and loose its active or caustic qualities. It is then "air-slacked," or "effete" lime, and has passed back again to the state of limestone, except it is in powder and nearly resembles chalk. Its caustic properties may be restored again by re-burning. Although effete lime is no longer useful for mortar, it answers well for manure, especially if it be in fine powder, so as to mix intimately with the soil. Indeed, the principal advantage of burning lime for agricultural use, consists in the fineness to which the powder is reduced by subsequent slaking; and hence mills have been erected to pound or grind limestone into a powder without burning. It is said that limestone thus powdered, has acted beneficially when applied as manure.

There is a popular notion that a stone which will not slake by burning contains no lime, or in the words often used to me, "it has'nt a particle of lime in it." A stone may be one-third of it carbonate of lime, and yet, after thorough burning, refuse to slake. Lime exists also combined with other acids than the carbonic, as with sulphuric acid, when it constitutes plaster-of-paris; with the fluoric acid, when it is the fluor or Derbyshire spar; with the nitric acid, when it forms a species of nitre often found in limestone caverns, as in the Mammoth cave of Kentucky. In none of these combinations will it "burn into lime," which will slake. It exists also in small proportion in most of the compound rocks, even in granite ; and is presumed to be an indispensable constituent of all soils, as it enters into the composition of plants, which can derive it from no other source than from the soil. Lime is also an essential part of animals, being the basis of the bones, and existing in other parts in smaller proportions.

Animals obtain lime in the first place from the milk of the mother, which abounds with it, combined, however, with various acids; and afterwards from their food, whether it be animal or vegetable.

But the business of my report is not to consider lime in these forms of general distribution, but in the state of carbonate of lime. This

exists mostly as a rock of various degrees of hardness from that of marble to the soft condition of chalk. It is often combined or rather mixed with clay, constituting marle, and forms the crust of the egg-shell, and the covering of the clam, the oyster, and other shell fishes.

With excess of carbonic acid it is sparingly soluble in water, constituting "limestone water." As a rock, limestone is extremely varied in its appearance; when pure and perfectly crystalized it is clear and transparent as glass, and is called calc-spar, Iceland crystal, &c. When pure and imperfectly crystalized, it constitutes white marblo, often resembling pure loaf sugar. In chalk it has no appearance of crystalization, but is a white earthy powder slightly coherent. From various impurities in small quantities, lime stone is extremely varied in color, having every shade, from snow white to jet black, and every hue of red, orange, yellow, green, blue, indigo, and violet. It is often white, gray, yellow, brown, or blue. So extremely varied is it in texture, hardness, color, &c. that few persons can pronounce with certainty from the appearance of a stone whether it be limestone or not. It is, however, when nearly pure, always so soft that it may be cut with a knife, is seldom more than twice and a half as heavy as water, will effervesce or foam with acids, and after a long continued red heat acquires a caustic taste, and the property of changing blue vegetable colors to green.

General Geology of the southwest part of Ohio.

The rocks in the western States, below the coal formation, have evidently been deposited in the bed of a deep primitive ocean, and consist of alternations and MIXTURES of CRYSTALLINE and SEDIMENTARY matters mostly in thin layers of from one inch to two feet. The *crystalline* or sub-crystalline strata, are mostly carbonate of lime. The *sedimentary** strata are, in the lower portions, clay marle, and in the upper portions, clay and sandstone. The *mixtures* are, in the lower portions, lime and clay forming either a durable slate limestone or an indurated marle which falls to pieces on exposure to the air; in the superior portions, lime, clay, and sand, forming an arenaceous limestone. All of these formations abound with the fosilized remains of Marine animals, sometimes so abundant as to appear to have lain originally in contact.

Stratification and super position of Rocks in the southwest quarter of Ohio, beginning at the bottom.

[*See plate No.* 1.]

1st. Blue sandstone, (coming to the surface at Cinninnati, and almost all places within 50 miles of it,) in thickness, at least 1000 feet.

2d. Clay marle, (at West Union,)	....	25
3d. Flinty limestone, (do)	....	51
4th. Clay marle, (do)	....	106

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* Mechanical deposites.

5th.	Cliff limestone, at West Union	89
6th.	Slate, (at Rockville)	251
7th.	Waverly sand-stone, (east line of Adams county)	343
		1,865

Dip.—The strata are nearly horizontal, and having a slight and irregular undulation, the dip is with difficulty ascertained, while one confines his attention to the layers of the same formation, for example, to the blue limestone about Cincinnati. The inclinations resulting from undulation, are seldom more than one foot in 45; and unless water be contiguous to mark the level, the strata appear to the eye to be quite horizontal. I have examined the inclination of the strata of blue limestone about Cincinnati very particularly with the leveling instrument, and have sometimes found a uniform and consistent dip for half a mile; in another locality the dip would be in an opposite direction. The strata in the bed of the Ohio at its lowest stage in Sept. 1838, showed, by comparison with the surface of the water, that these local undulations were extremely irregular, presenting inclinations which vary in all possible directions, in planes continued uniform not generally more than one fourth of a mile. A single stratum cannot in general be identified far enough to determine on the whole, whether it has, independent of local undulations, an absolute dip. However, when we examine the several formations, previously named, on a large scale, the dip becomes very evident; and as one formation sinks gradually below the surface, and another superior one presents itself, gives rise to those important changes in the face and productions of the country, which we should hardly attribute to a slope so moderate as one inch in a rod. By a correspondence held between Dr. Owen, the Geologist of Indiana, and myself, it has been ascertained that the strata slope downward each way from a line not far from that between Ohio and Indiana, pitching eastwarly in Ohio, and westwardly in Indiana, in such a manner that the cliff limestone, which shows itself not many miles east and west of Richmond, in Indiana, descends and comes to the bed of the Ohio river, at the east side of Adams Co., in Ohio, and at the falls of the Ohio, at Louisville.

It follows as a consequence of this arrangement, that the out-cropping edges of the strata present themselves at the surface in the same order in the two States, but proceeding in opposite directions. For example, on *ascending* the Ohio eastwardly, we meet with blue limestone, cliff limestone, slate, fine sandstone, conglomerate, and coal. On *descending* the Ohio westwardly, we meet with the same things, in the same order, viz: blue limestone, cliff limestone, slate, &c.

Blue Limestone Region.

The blue limestone is the lowest rock which has been penetrated in this region of country. With its alternate layers of marle and marlite, it is the exclusive rock, even to the tops of the hills, from West Union,

in Adams county, to Madison, in Indiana; and from Dayton, in Montgomery county, and Eaton, in Preble county, on the north, to a line 80 or 100 miles up the Licking river, in Kentucky, on the south. At these places, or within a few miles of them, another rock, the cliff limestone, is found on the tops of the hills; but the blue limestone is still found in the beds of the streams, extending in some instances 20 miles further, as will be seen in the following details. I am not well informed how far the blue limestone extends south of the Ohio. I think it is found at Lexington, but the banks of the Kentucky river at Frankfort, are of the cliff Limestone.

It appears then that the blue limestone passes under all of the other strata, and even where it does not show itself at the surface, might be found by boring to a sufficient depth.

Characters of the Blue Limestone and of the surface where it abounds.

The surface of the country in which the blue limestone presents itself, is a table about 5 or 6 hundred feet higher than low water of the Ohio. This table appears to have been originally an even level, and is now varied only by the valleys and channels which the streams, "mining the soil for ages," have excavated for themselves. These channels are sometimes bounded closely by abrupt banks, but they generally extend from half a mile to four miles in width, the streams meandering through a rich arable alluvion, called "bottom lands." Indeed this description of surface is applicable to a large portion of the western valley. Portions of this table lying between the heads of streams where it has not been sloped or channeled by water, although the highest ground in the country, are often so flat that the water does not drain off readily, and they appear wet and "swampy." It is often partially inundated during spring and wet seasons, by shallow lagoons, yet not sufficiently to prevent or destroy the growth of trees.

From this it will be inferred that we have in fact neither mountains nor hills; yet when one is in the valleys which are 5 or 6 hundred feet deep, with a descent almost always rapid, and often precipitous, and cut into spurs by lateral ravines, he has every appearance of beautiful rounded or conical hills, as along the banks of the Ohio and around the plain of Cincinnati. In accordance with common language I shall occasionally use the term *hill*, to signify the slopes and spurs of the above described table.

The blue limestone in Hamilton and the contiguous counties, is found in strata from the thinnest possible, often less than an inch, to 2 feet in thickness, and is mostly from 2 to 8 inches. These layers are nearly level, of uniform thickness, and may be traced and identified sometimes for half a mile. The same layer will sometimes run out and give place to others of a different thickness perhaps, but geologically identical. The several layers of stone are separated by layers of blue clay marle, which forms in the neighborhood of Cincinnati quite two-thirds of the whole mass. The proportion of solid stone to the marle, in different localities, is variable. At Aberdeen and Maysville the

stone is much increased, and the hills become more solid and precipitous. In proportion as the marl is abundant, the layers of stone become broken and undulating. Hence we infer that the undulations above described, are the effect of unequal settling of the stone lying upon a soft yielding bed. The layers of stone are generally broken by vertical seams, into irregular fragments from one te six feet in diameter; yet entire pieces of 20 to 30 feet in extent are sometimes quarried. These characters of the rocks give peculiar features and qualities to the surface As the marle becomes exposed on the precipitous banks of ravines and rivers, and is softened and removed by the action of the weather, the *fragments* of the stone fall successively, slide down with the earth, and are never left standing out in cliffs or extensive out-croppings. The hills and banks of streams become generally rounded in form, and are not broken except by slides, which in the wet season take place in portions of several rods in extent, especially where the marle is predominant, and where the trees have been cut down and the roots which bound the soil together have become rotten. Occasionally these land slips carry a few trees along with them. This interstratification of soft marl, and this broken condition of the solid layers, prevent also the formation of natural caverns, and are an impediment to quarrying by drifting or tunneling. This peculiar structure is highly favorable to agriculture, and maintains inexhaustible fertility, especially on the slopes from the tables to the streams. The marle although more or less indurated, sometimes to the state of a solid stone, disintegrates and crumbles to a soil, when exposed to the alternations of the weather; and thus, although the vegetable mould may, by washing or by a slide, be entirely removed, there remains the basis of another fertile loam, which is made ready for use simply by exposure to the air. The water too, which is borne out upon the slopes by the layers of marle, comes surcharged with lime and other fertilizing salts, "liming" and manuring the soil perpetually. Whenever a well has been dug in the table lands, and the marle thrown out, the grass and weeds spring up in and around it with increased luxuriance, and I have no doubt that this material, so abundant, will become a valuable manure, to the *table lands* especially, some of which are already exhausted.

Many persons suppose that it is the business of the geologist to find gold and silver mines, and that he renders no service to the State unless he does that. While on my excursions, I got out of all patience with being asked if I was hunting for "*goold*." The State of Ohio has the richest gold mines in the world in the great fertility of her soil, and any geologist who should suggest the means of perpetuating or improving so invaluable a blessing, would confer a greater benefit on the State than by discovering a gold mine to turn the brains and corrupt the morals of the community.

I beg leave to make the following *suggestions* with regard to the nature of our soil, and the use of calcareous manures. They are mere suggestions, the utility of which can be determined only by experiment. It is the opinion of geologists, that the character of a soil is

determined by the rocks which lie underneath it, the soil being formed by the disintegration or decay of those rocks. This, though generally true, has numerous exceptions. The soil in the southwest portion of Ohio has been formed mostly from rocks and marl, identical with those which now lie beneath it, except where it has been brought and deposited by waters, forming what is called alluvium or diluvium. But the soil formed by disintegration does not contain, at the surface, so much lime as we should anticipate; and rarely, if ever, where undisturbed, does it effervesce or foam with acids. On the tops of the hills around Cincinnati, the loam lies 7 to 9 feet deep before any stone are mingled with it, *and this loam is not effervescent with acids.* But as soon as a layer of stone has been passed, all below it is highly so. I have observed the same fact in other situations remote from each other. It would seem there is a kind of *bleaching* process by which lime is dissolved and removed from the upper part of the soil. The carbonic acid formed by vegetable decomposition, and entering the ground with the water of rains, dissolves limestone, and carries it off in the form of "limestone water," *bicarbonate of lime.*

The vegetable acids which exist in the natural juices of plants become saturated with lime as they pass through it, and form soluble salts, which are washed away by the rains. These causes, operating for ages, have evidently bleached the surface, especially on the table lands, till, in my opinion, there is an absolute want of calcareous matter. If this is the fact, the clay marle found every where between the layers of rocks, would be a beneficial manure, and burnt slaked lime would be still more useful, and would undoubtedly renovate the wheat and grass lands, which, on the table lands, are to some extent worn out.

But in applying calcareous manures, care should be taken that vegetable matter be also supplied, as by direct application or by ploughing under a clover crop. This is no place for a treatise on calcareous manures, and those who wish for information will find abundant interest in most of the popular works on the subject.

The clay marle near the surface, and where changing water and atmospheric agency have had access to it, is of a yellow or reddish yellow color, but below such influences it is of a dove blue. The loam immediately under the vegetable mould is very nearly the color of wheat just ripe for the harvest. Indeed, in most situations in the vicinity of Cincinnati, the clay marle gives character to the soil which in wet weather, especially in the roads where it is trodden, becomes a deep unctuous adhesive mortar, through which travelers wallow at the rate of one and a half to two miles per hour. In time of drought such a soil will of course bake, so as to become impervious to the radicles of plants, and will scarcely sustain vegetation. Hence, those crops which require the last of July and the first of August for perfecting themselves, are liable occasionally, to be materially injured. Even the very beds of the lagoons on the table lands become arid and cleft with drought. The northern part of the State of Ohio has a covering of diluvial sand, gravel and boulders, which in some places approaches to 100 feet in thickness. Traces of this di-

luvium, such as layers of quartzose sand and gravel, even on the highest tables, are found quite across Butler county. The beds and banks of streams abound with such sand and gravel, which promises to be a useful material in the construction of roads, and the sandy part of it would be a useful manure where the soil is too heavy and clayey.

The yellow loam near the surface appears to be the clay marle bleached of its lime, and hence, is more useful for the manufacture of bricks than that which comes from between the layers of stone; the latter is uniformly effervescent and contains from 12 to 35 per cent of carbonate of lime. It often contains glimmering fragments of mica, has an unctuous feel, and although often indurated, it is still so soft that it can be easly cut with a knife; and has hence obtained the name of "soap-stone." It has fewer fossils in it than the layers of limestone. Indeed, it often appears, to a great extent, to contain none at all, while the limestone is filled with them.

Of the Blue Limestone.

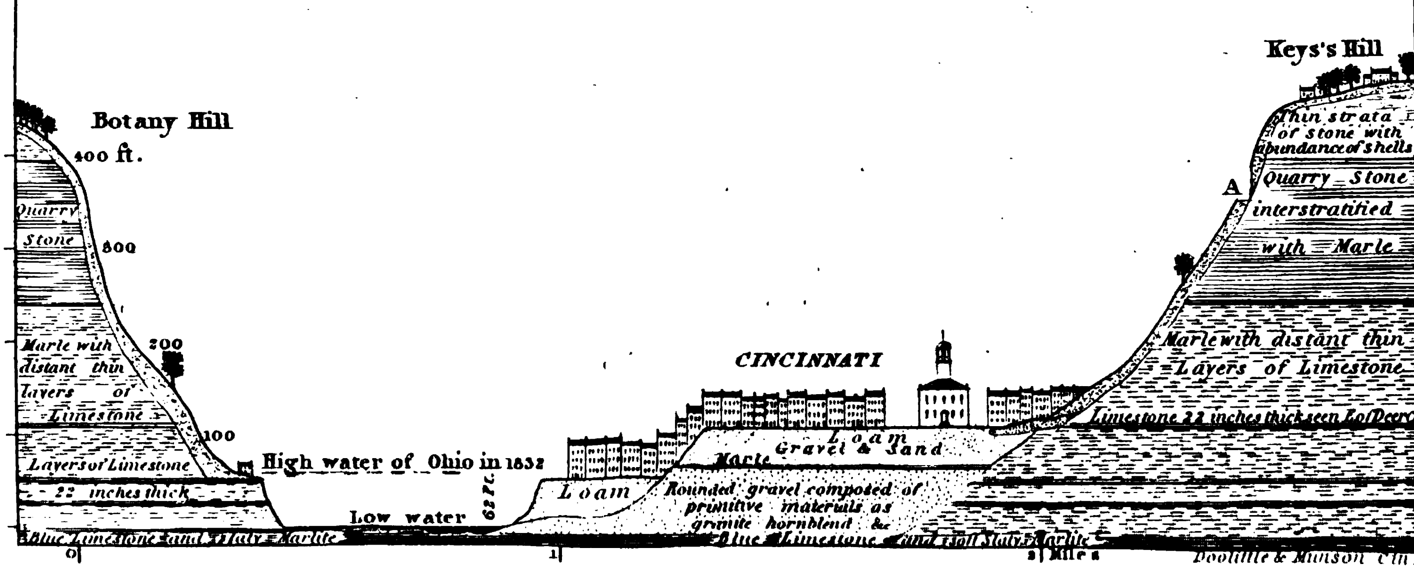
This, as already mentioned, lies in layers alternating with the marle, broken but not displaced, there being no faults or dislocations. It has a blue color, granular crystalline fracture, a good degree of compactness, the hardness of marble, and gives a sharp clear sound when struck with the hammer. It is very useful for a building stone, for burning to lime, for M'Adamizing roads, and will often receive a fine polish as a marble. In this latter use, the numerous shells and other marine organic remains, abundantly deposited in it, add to its beauty; their sections being marked by sometimes a white crystaline line or spot, and sometimes by one of a tortoise shell brown. Its fault as a marble is, that it contains some spots of clay or marle not susceptible of a polish. The cavities of the shells are not often hollow, but are frequently filled with white clear crystalline spar. Sometimes when they are hollow, they are lined with points of dog-tooth-spar. It is seldom stained deep brown with iron, and more rarely still contains iron pyrites. In Adams county, at a particular layer, the fossils of the blue limestone are pyritic, and when the stone is broken, presents them in a most beautiful frosting, or bronzing of golden color. A fragment of a large trilobite ornamented in that manner, formed the most beautiful fossil which I have ever seen.

The following is the result of an analysis of a specimen of the blue limestone from the hills of Cincinnati, made by myself, and published in the report of the first committee on the subject of the survey:

		Grains.
1.	Carbonate of lime	90.93
2.	Peroxide of iron	3.15
3.	Matter insoluble in muriatic acid	1.80
4.	Carbonate of magnesia	1.11
5.	Silex from solution	0.77

No. 2

SECTION *of the* **VALLEY** *and* **CHANNEL** *of the* **OHIO RIVER,**
at **CINCINNATI** *from* **KEYS'S HILL** *in* **OHIO,**
to **BULLOCKS** *or* **BOTANY HILL** *in* **KENTUCKY.**
Surveyed & drawn by JOHN LOCKE.



6.	Water expelled by red heat	1.13
7.	Loss	1,11
		100.00

Besides this limestone, so nearly pure, there are some layers with fewer fossils which are more or less argillaceous, and even slaty in their structure. They have a dark slaty color and a feebly crystalline or dull earthy fracture. Their surfaces are smoother than those of the limestone, and where they will stand the frost and the weather they are often used for curb stones. Some of them have been used as a hydraulic cement, and are said to have answered the purpose well. A specimen from the mouth of Licking, containing 56 per cent. of carbonate of lime has been used for water lime. It is a mere marlite, and crumbles to an earth on exposure to the weather.

"The Cliff Limestone."

The above name has been adopted for the very extensive deposite of limestone above the blue limestone, and separated from it by marle and by a siliceous formation, which, in Adams county, is 50 feet thick, but in other situations is reduced to a few inches, and in others again, may be wanting.

I have already stated that the blue limestone, on account of the thinness of its layers, the interlamination of clay marle, and the numerous fractures which traverse it, never stands in mural cliffs. But this superior stone occurs sometimes 80 feet thick without a seam, and of course when cut by the valley of a stream, stands in mural or overhanging escarpments. On this account it has received, by the inhabitants, the name of "cliff," "cliff stone," and "cliff limestone," which is sufficiently distinctive on the confines of the two kinds of rock. For the reasons above given, the blue limestone forms no cascades or caverns, but the cliff limestone does both; and when I was coasting the outline of the cliffs, instead of inquiring for a peculiar stone, I inquired for cascades and was never misled by the information. In accordance with this nomenclature, a creek which falls into the Ohio below Madison, (Ia.) and makes in its course some magnificent leaps over the cliff limestone, has received the name of "Clifty creek," and the cascade that of "Clifty falls," the *t* being added agreeably to a common provincialism of the west, which makes a skiff, a "*skift*;" a cliff, a "*clift*," &c. Clifton, a town north of Xenia, is just at the commencement of the same stone, and has borrowed its name from it.

Extending from Cincinnati in several directions the blue limestone disappears under the cliff limestone at the following places: Adams county, near the eastern line, it disappears under the water of the Ohio river, and 5 or 6 miles east of the western line it disappears under the surface of the soil; between Xenia and the Yellow Springs in Clarke county; at Dayton in Montgomery, the blue limestone is covered by the cliff on the hill tops; a few miles below Troy it disappears

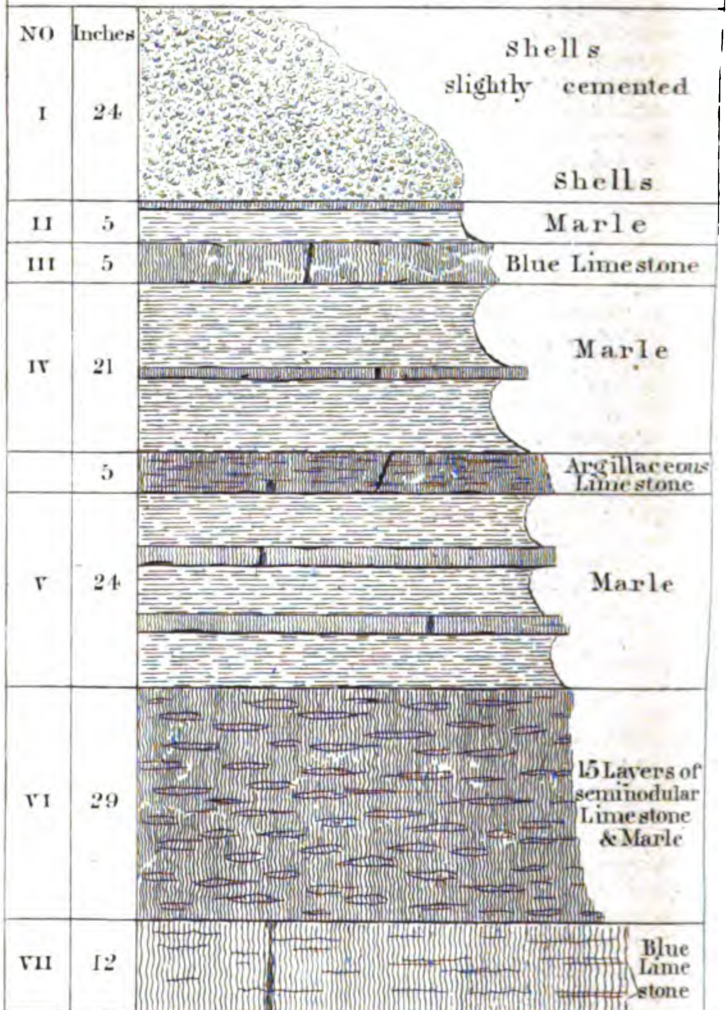
under the canal; two miles south of Eaton, in Preble county; at Radcliff's tavern, at the north line of Butler county, the cliff limestone occupies the hill tops, probably as an outlier; a few miles west of Richmond, in Indiana; Versaills in Indiana, and in a line from that place to Madison, in the same State. The above places have been examined by myself. The blue limestone is covered by the cliff limestone, I am informed, about 80 miles up the Licking, in Kentucky. At Louisville the cliff limestone crosses the bed of the Ohio and forms "the falls." At the above places the cliff limestone commences and occupies the surface indefinitely until it disappears in some places under the slate, and in others under deep deposites of diluvium.

The cliff limestone is very various in its character in different localities, and even in the same locality, the same solid rock will present several horizontal layers very different from each other. It is generally less hard and compact than the blue limestone; often extremely soft and friable, like loose sandstone; sometimes porous and spongy, like pomice-stone, as at Eaton, in Preble county; arenaceous, containing silicious sand, as at West Union and Madison, Ia.; compact and marble-like as at the Dayton quarry. In some localities it is nearly destitute of fossils, while in others it is a cementation of piles of them many feet in thickness. In color it is often yellowish, reddish, gray, or even nearly white. In most places it is more or less bituminous and fœtid, and cavities in it are often filled with liquid bitumen. Its out-croppings are generally peculiarly ragged and picturesque, the stone being perforated with holes and cavities from an inch to more than a foot in diameter, while the tops are not unfrequently overhung with fantastic cedars. The fossils which I have noticed in the cliff limestone, although partly identical, are mostly different from those in the blue limestone. There are coralines, univalves, bivalves, and trelobites in both, but the species are generally different. The coralines, in the blue limestone, are mostly small and branched, such as are popularly called "petrified sticks," while those in the cliff limestone are often very large, cylinders 4 inches in diameter, or hemispheres sometimes 3 feet in diameter. The blue limestone abounds with the Strophomena of Raff., while the cliff stone has few or none. The fossils of the blue limestone often have the shell itself, still preserved; but in the cliff stone the cast only is found and that often beautifully frosted with minute crystals as in specimens of bivalves and trilobites from Springfield. The blue limestone contains abundance of small encrinital joints; and the cliff stone those of a larger size, more than an inch in diameter. It not unfrequently has the cavities or moulds of portions of the encrinital column with even the slender axis which filled the central hole of that column still entire. A complete catalogue of the fossils of our limestone deposit cannot yet be furnished. But the materials are rapidly accumulating; and although I am not charged directly with the duty of examining fossil remains, I have still collected such as have come in my way, and have borrowed from private cabinets rare specimens for the purpose of making plaster casts of them. These casts I intend for the State cabinet. My acknowledge-

No. 3

SPECIMEN SECTION of the Blue Limestone taken at Keys's Hill Cincinnati.

BY JOHN LOCKE.



Total 10Ft.5 Inches

ments for favors of this kind are due to Mr. McBride, of Hamilton, Mr. Buchanan, Mr. Graham, Mr. Anthony, Mr. Carley, Mr. Lapham, and Miss Longworth, of Cincinnati.

So far I seem to have said more about the vicinity of Cincinnati, and the blue limestone region generally, than concerning Butler county in particular, to which I was especially ordered. My excuse for this is, that the geology of Butler county is almost identical with that of Hamilton; and all that I have said of the blue limestone in general, is applicable to Butler county in particular, as will more fully appear in the subsequent details of my observations in that county and its vicinity. The accompanying plate, No. 2, showing a section of the valley and channel of the Ohio at Cincinnati, will give a general idea of the stratification of the blue limestone formation.

Details of examination made by Dr. Locke.

Having thus given a brief outline of the geology of the region which I have been required to examine, I now proceed to the details. During the months of March and a part of April, I made a journey to Urbana and Columbus, in order the better to ascertain from the Governor and from the Principal Geologist, what course had been determined upon since the legislature had not renewed an appropriation for continuing this survey. In this journey I made several observations, at Dayton, Springfield, Urbana and Columbus, to determine as accurately as possible, the magnitical dip and intensity at those places. As these observations did not make a *formal* part of the business of the survey, although certainly not inconsistent with it, I communicated the details of them, through Mr. John Vaughan, to the American Philosophical Society, who have honored me with the following notice of them, published in the Journal of the Franklin Institute, of Pennsylvania, for October, 1838:

"*July 20—Mr. Du Ponceau, President, in the chair.*

"*Magnetical dip in Ohio.*—The committee appointed on the communication of Dr. John Locke, of Cincinnati, read at the last meeting, made the following report, which was adopted:

"'The committee to whom was referred the communication of Professor John Locke, of Cincinnati, report, that it gives the details of a series of experiments made for determining the magnetic intensity and dip for certain positions in Ohio. For these experiments he had furnished himself in London, and had vibrated there, [at the Greenwich Observatory.] two needles of the form recommended by Hansteen, and one in the form of a small flat bar. Five months afterwards, namely, on the 17th of January, 1838, he again vibrated these needles at Cincinnati, and found the ratio of the horizontal intensity at the former place to that at the latter, as follows: By needle No. 1, as 1 to 1.1624; by needle No. 2, as 1 to 1.1639; by No. 3, [the flat bar.] as 1 to 1.2037.

"On the 20th of August, 1837, he made experiments with his dipping needle, to determine the dip at Westbourn Green, near London, the mean of which gives 69° 23'.3.

"On the 26th of November, 1837, the mean of a series of experiments made at Cincinnati, in latitude 39° 6' N., and longitude 84° 27' W., gave the dip=70° 45'.75.

"At Dayton, Ohio, in latitude 39° 44' N., and longitude 84° 11' W., the dip was found to be 71° 22'.75.

"At Springfield, Ohio, in latitude 39° 53' N., longitude 84° 11' W., the dip was found, on the 29th of March, 1838, to be 71° 27'.375.

"At Urbana, latitude 40° 03' N., longitude 83° 44' W., March 30, 1838, the dip was found=71° 29'.94.

"At Columbus, the seat of government of Ohio, April 3, 1838, the dip was found=71° 04'.875.

"The interest of this paper is very much increased by the circumstance that no accurate experiments on the intensity and dip of the needle, have heretofore been made in the United States, west of the Allegheny mountains."

I made also an excursion, in company with the Principal Geologist, and with Messrs. Briggs and Foster, through the coal measures of the southeast part of the State. During the latter part of April, while a suitable horse and wagon for the service was being procured, I employed myself in making examinations in the vicinity of Cincinnati, where the blue limestone, deeply excavated by the valley and immediate channel of the Ohio river, and extensively opened by quarrying, affords to the geologist peculiar advantages for observation. I carried on a system of leveling and triangulation along an opened stratum for more than a mile, and although I found to that extent it laid in nearly a uniform plane, inclined about 1 foot in 45 to the northeast, yet this dip was by no means constant or even predominant in the contiguous layers. The result of the whole was, that no evidence of a predominant dip or descent from a general level is apparent in the layers of rocks about Cincinnati, and to ascertain the dip of strata, such as ours, requires observations on a scale much larger than a few miles.

The section (No. 2) of the valley and channel of he Ohio at Cincinnati, is the result of my observations, and gives a fair sample of the blue limestone formation wherever it has come under my observation. In the height of 500 feet here exhibited, there are more than a thousand distinct strata, but as they are repetitions of merely 3 or 4 sorts of rocks, it would be a useless particularity to give a detailed section of them. In such cases I have thought it best to give *specimen sections*, viz: Sections of small characteristic portions exhibited on a large scale. This mode of giving sections has the capital advantage, that it is recognizable by the practical man. The quarryman, when the section is given on a scale of 2 feet to the inch, can actually find what he wants by means of the "pictorial illustrations." The specimen section, No. 3, is taken from the upper ten feet of our hill quarries.

(See A, No. 2.) The lower thick stratum is particularly sought for as a building stone, the slaty layer for curb stone, and the intermediate thin layers for McAdamizing. The upper and shelly stratum is rarely passed by our quarrymen, but is the object of attention from our fossil hunters.

The gravel bank on which Cincinnati stands is not unlike others along the Ohio, and consists of sharp quartzose sand and rounded masses of hard primitive rocks, cliff limestone, and blue limestone, from fine gravel up to small boulders 6 or 8 inches in diameter. Insulated masses of coal and occasionally the bones of the elephant occur in it. As the cliff limestone pebbles make a lime of uncommon whiteness, they are often selected, burned and sold under the name of "pebble lime," for the purpose of whitewashing. The older and higher alluvial banks of the Ohio often consist of a very tenacious blue marle, containing pebbles, masses of stone, and buried wood occurring 70 to 100 feet above the present high water mark. A peculiar fine loamy sand is another ancient alluvium which often skirts the hills at about the same height. Both of these occur in the plain of Cincinnati; the former underlies a part of the old race ground, and the latter is found near the Woodward college, where it is dug by iron and brass founders, for the purpose of moulding for castings. The most interesting exhibition of the alluvial clay marle is at North Bend, and within a short distance of Gen. Harrison's residence, where a tunnel of the White water canal is now being excavated through it. But I have not been ordered to report a survey of Hamilton county, and have made the above observations incidentally, as I have traversed that county in various directions.

On Monday, May 7, after having waited a whole week on account of continued rain, which had not yet ceased, I started for Butler county, to which especially I had been ordered. I started with the following equipage and instruments:

1. A horse and light waggon.
2. A portable barmometer, made by Bunten.
3. Thermometer.
4. Clinometer.
5. Pocket sextant, by Troughtom & Simms.
6. Microscopic compass, by the same.
7. Level and stand, by the same.
8. Case of drawing instruments.
9. Microscope.
10. Balance and weights.
11. Tape measure.
12. Camera lucida.
13. A hammer for breaking stone.
14. A leather valice for collecting specimens.
15. Several chemical tests.

I deemed it necessary to take along several portable engineering instruments, as I did not expect to be accompanied by the Topographical engineer.

Examination in Butler County.

My road was by way of Sharon and Chester, to Hamilton, the county seat, 27 miles. A section along this road, especially from Chester to Hamilton, would present, in general, the following items:

1st. A rich black mould 1 to 2 feet.

2d. A yellow clayey loam, about 1 to 7 feet.

3d. Gravel of variable thickness.

4th. Blue limestone of indefinite thickness.

At the distance of two and a half miles west from Chester, there is a hill having a quarry of blue limestone similar to those at Cincinnati. This hill I ascertained by the barometer to be 205 feet above the plane below. The prospect from its summit, especially towards the south, is extensive and beautiful. Boulders of small size were seen within five miles of Cincinnati. On the confines of Butler county they occur from two to three feet. Some of them consist mostly of red feldspar.

After arriving in Hamilton, I examined a stone quarry in Rossville, opposite to that town, and found the local dip to be N. E. 85 feet per mile. At Hamilton I became acquainted with Messrs. McBride and Erwin, who having been practical Engineers and surveyors, in and around Butler county, were enabled to furnish me with much precise and valuable information. Those two gentlemen had surveyed and plotted many of the ancient works, which are numerous in Butler county, and they kindly permitted me to copy quite a number of those surveys and plans, but space and time hardly permit me to offer them for publication. I had the curiosity to survey one of them myself, and I found it well worth the attention of the curious. It is situated on the farm of Moses Line, four miles above Hamilton, and not more than one fourth of a mile from the canal.

Not far from these works, and still nearer the canal, on the brow of the hill, is a boulder of feldspar of 3 or 4 tons weight. Porcelain is now manafactured in Cincinnati, and this boulder is the substance of one of the materials If an extravagant price should be demanded for it, the manufacturer can find another elsewhere, and leave this still an encumbrance to the soil. In returning to Hamilton, we passed over several hills which were probably 200 feet above the plain. The section of these hills would be as usual in this county:

1. Rich fertile mould.
2. Loam.
3. Loose stone and loam.
4. Interstratifications of blue limestone and marle in place.

Although in some of the lowest places, water was at this time standing, yet it dries up early enough not to impede the growth of trees, for large ones were standing in the midst of it. The soil is evidently very fertile, bearing, when cultivated, the finest crops of maize, wheat and grass; and when in the state of nature, gigantic forest trees, consisting of sugar maple, oak, black walnut, elm, sycamore, hickory, honey locust, ash, &c.

Information derived from Mr. J. W. Erwin, State Engineer:

1. "In Preble Co., Somers township, section 32, there is a ridge 500 feet above the level of the Miami at Hamilton, capped with a crystalline drab limestone, different from the blue limestone. This is near Ratcliff's tavern.

2. "In Jasper township, near two miles south of Eaton, at Halderman's quarry, there is a sandstone which stands fire, and a variegated and drab limestone, used for capping the works at the locks, on account of its uniform thickness and smooth surface. The same occurs in Israel township, about one mile north of Fairhaven, 8 miles west, and 4 miles south of the locality in Jasper township."

The following levelings were obtained from Mr. Erwin:

	Feet.
Quarry at Ratcliff's, north line of Butler county, above the Miami river at Hamilton	470
State line, N. W. corner of Israel township, Preble county, Sec. 19, above same point	525
Sill of Preble county court-house, in Eaton	481
Water of the canal basin at Hamilton, above low water of the Miami at same place	37.74
Somerville, Butler Co.	203
Mouth of Paint creek	256
Camden, Preble co.	276
Sixth crossing of Seven Mile creek, Eaton turnpike	382
Halderman's quarry is half a mile from this point, and about 30 feet above it, being	412

Levels of the Miami canal above low water of Ohio, at Cincinnati.

	Feet.
Hamilton basin	169
Middletown	211
Franklin	248
Dayton	297
Aqueduct	349
Feeder below Troy	368
Top blue limestone below Troy	388
Piqua	426
Low water of Miami at Hamilton is then, above low water of the Ohio at Cincinnati	131

The above number 131 is to be added to the several heights referred to the Miami level, in order to reduce them to the level of the Ohio at Cincinnati. By this addition, the northwest corner of Israel township becomes 656 feet.

Hamilton to Darrtown, 8 *miles.*

Three miles from Hamilton we crossed Bell's hill, which is about 500 feet high, overlooking the valley of the Miami at Hamilton and

far beyond. The upper part of this hill, for perhaps 100 feet, consists of very perfect but rather thin layers of blue limestone, with but little marle between them. The soil on the top is deep and fertile, and the wells afford a sufficiency of water.

This hill descends gradually towards Mr. Becket's; soil rather thin but calcareous and well calculated for wheat. At a branch of Four Mile creek I examined the stratification where the stone cropped out at the water's edge, and found the local dip to be northwest about 30 feet per mile. We crossed Four Mile creek near Darrtown, where an extensive sand bar had been formed by the late flood. The sand was mainly silicious, but contained so much lime as to effervesce powerfully with acids. Among the gravel occurred angular pieces of flint, (chert) quite white on the exterior, and slightly efferescent, but of a darker flinty color in the interior.

Darrtown is situatedon a plain 20 feet perhaps above the level of Four Mile creek. It has clay and a thin layer of broken limestone underlying it, and gives rise to numerous springs in the surrounding banks The soil at several places in Darrtown and vicinity is exceedingly black and light, being filled with vegetable matter and is evidently prairie-like.

Chalybeate Spring at Darrtown.

On one side of Darrtown the springs are discharged into a portion of ground rather low, and form a small wet prairie across the outlet of which there is a ridge evidently the remains of a beaver dam. A few rods west of the prairie, a chalybeate spring gushes out into a branch of the creek. It boils up from sand and mud in its basin, and running about 30 feet, enters the stream contiguous with little descent. An iron film collects on its surface and the channel becomes stained with iron rust. Once in about 10 seconds there is a discharge of bubbles from the various apertures through which the water boils into the basin.

As I had come to Darrtown merely on a *recognizance* with several gentlemen from Hamilton who had come to a turnpike meeting, I had brought no instruments. Dr. Crookshanks, of Darrtown, who accompanied me, procured a glass tumbler, a lighted candle, and some matches, with which apparatus we proceeded to collect the gas and subject it to experiments. We found it to be incombustible, and in no degree a supporter of combustion. It immediately extinguished burning bodies thrown into it, but it showed in no degree the weight of fixed air. The probability is, that it is a mixture of carbonic acid and nitrogen. About 20 gallons of water per minute, were discharged by the spring. The water is clear, and has a chalybeate or iron taste, similar to that of the yellow springs in Green county. It seems to have every quality of a medicinal chalybeate, and should it ever become a fashionable resort, would undoubtedly claim the credit of a fair proportion of cures.

Return to Hamilton. Having made my examinations I advanced

a mile further north to the "crossings," then 4 miles east to the Eaton turnpike, which I followed to Rossville, opposite to Hamilton. In this little journey I noticed several large boulders and the great abundance of gravel, consisting both of granite and limestone, which underlies the alluvium of Seven Mile creek, and forms its bed. From these sources the "company" are very judiciously constructing their gravel pike from Hamilton to Eaton. The greater part of this road is now coated with the gravel, which seems to "pack" as well as the broken stone of McAdam, and costs only about half as much.

Hamilton to Camden, eighteen miles.

My route for the first part of the way was the same as that to Darrtown. Two miles from Rossville, at Mr. Beaty's, I noticed the finest "sugar orchard" which I had ever seen. The soil was fertile, and the trees, which were young and 6 to 30 inches in diameter, were 120 feet high. I went into the grove and measuring off a rood of ground counted the trees upon it, and found them to be 45 in number, or 180 to the acre. The average annual product per tree, and the price per pound, would afford the data for calculating the income of land so appropriated. These sugar orchards, which are formed by nursing and protecting the natural growth of the sugar tree, are not uncommon in Butler county. Besides their direct utility, they afford a magnificent ornament in the landscape.

I dined at Mr. Becket's, where I had anticipated the pleasure of meeting Mr. Erwin. Mr. Becket's is about 4 or 5 miles from Hamilton, and 136 feet above the level of the Miami. I observed the barometer at this place, and found it to read, May 12, 1838, 1, P. M., at Mr. Becket's, 746.1 millimetres. Cent. therm. 22°.

From Darrtown I advanced along a branch of Four Mile creek, called Darr's run. The blue limestone was frequently apparent, and numerous boulders of large size presented themselves.

At Hersey's I observed that the rocks in the run were tilted at a very high angle. Upon search I found there was underneath them a bed of greenish blue marl, of a very light color, almost white when dry, and highly effervescent with acid, had become soft by frost, and bulging up by the pressure of the surrounding banks, had ruptured and upturned the thin stratum of rock which covered it. This light-colored marl belongs generally to the upper layers of the blue limestone in this neighborhood. Rivers emanating from it, are clearer than those from the drab colored marl, and have their waters tinged with a delicate whitish green, exactly like the waters of the Seine, in France, where chalk is, in part, the source of the color. The stream at Darrtown, showed this tinge in great perfection as I passed it.

At Ratcliff's tavern, which is 13 miles from Hamilton, and just at the north line of Butler county, the blue limestone disappears under the cliff limestone. Here the top of the blue limestone is 470 feet above low water of the Miami at Hamilton, and 601 feet above low

water in the Ohio at Cincinnati. My barometer, at this place, read as follows:

May 12, 1838, 6 h., P. M., at Ratcliff's tavern; 736.6 millimetres.

The above observation, and that at Becket's, would give the height at Ratcliff's, 595 feet; differing only 6 feet from the levelings of the engineers. The cliff limestone at this place, is of a singularly soft nature, and answers no useful purpose except that of being burned into lime, which is done with facility, and the lime made of it is peculiarly white, but is said to bear less sand, to make it into building mortar, than the blue limestone. The stratum of soft limestone is, here, about 3 feet thick. Below it is a stratum of marl 2½ feet thick; and below this again, are the layers of the blue limestone. These together form a bank, or out-cropping, 10 or 12 feet high, facing to the east, and running to the north parallel to, and a few rods from the road, for half a mile. The soil above is flat, level, and probably parallel to the stone which underlies it but a few feet below the surface. The soft limestone at Ratcliff's, appears crystalline, and nearly destitute of fossils, but a few rods to the north they are abundant and differ essentially from those in the blue limestone.

Among them I noticed a large oyster shell, numerous cyathophylla or "petrified calves' horns," the chain coral, and a layer of coralines in hemispheric masses sometimes a foot in diameter. These seem to be formed in concentric layers, one over another, in such a manner that when broken off, or detatched from their base, they exhibit distinct and well marked concentric rings, while the outside exhibits hexagonal cavities or elevations, about half as large as honey comb. Such fossils are popularly denominated "petrified hornets' nests." Mr. Vancleve, of Dayton, is of opinion that it is the calamipora spongites of Goldfuss.

About a mile northerly of Ratcliff's, and nearly on the same level, I was shown, by some young men of the neighborhood, an out-crop of the grey limestone, similar to that which occurs at Springfield. It presents to the north a mural front of about 8 feet high; and although it is composed of a great number of thin layers, yet they are all united and solidified without intervention of the marl strata, which uniformly accompany the blue limestone. A copious spring gushes out from beneath the stratum, and has so undermined it that a large cavern has been formed. A large mass of many tons of the stone has broken off and lies half overturned below. Through a cleft in the rocks, the earth from the level soil above, has settled down forming a conical depression called a "sink-hole," at the bottom of which, is an opening through the exposed rocks, large enough for a person to pass through into the cavern below. These caverns and cliff holes were formerly infested by rattlesnakes, a circumstance common enough on the confines of the cliffs. These last described rocks are undoubtedly superior in place, to the soft limestone at Ratcliff's. I know of no place at which the cliff limestone approaches so near to Cincinnati as at this locality, which is 38 miles. As the mean dip is an "indispensible datum" in ascertaining the geology of any portion of country, and as I had

sought it in vain within the blue limestone, I determined to enter Preble and Montgomery counties, to fix, if possible, two other points as precisely as I had the one at Ratcliff's, and thus determine the position of a plain triangle of large size. But before commencing any account of those operations, I will finish what I have to say on the subject of Butler county.

In passing down through the eastern part of Butler county, my attention was particularly arrested by the scenery from the top of a hill about half a mile north of Guilford, and probably on the property of John Robison. This hill commands an extensive view of the fertile valley of Dix creek, and its contiguous hills to the westward. Southwardly, it looked quite across the valley to Monroe, which is four miles distant, on the opposite side of it. It was in June, and the whole earth was a garden of verdure. The valley of Dix creek has an exceedingly fertile, black alluvion, extending in a plain quite across it. It produces fine grass and corn, but is almost too strong for wheat. How so small a rivulet as Dix creek could have excavated a valley 300 feet deep, and 3 to 4 miles wide, a valley sufficient for the majestic Ohio itself, is a geological problem, which I am unable to solve. Did the Little Miami ever pass in this direction? The canal now building from the Miami canal to Lebanon, through this valley, might seem an absurd undertaking; but to open a conveyance for the produce of such a region, is well worth the enterprise, independent of the interests of the thriving town at its termination.

In passing through the western part of Butler county, in company with Dr. Owen, the geologist of Indiana, our road lay along the valley of Indian creek, a tributary of the Great Miami, and here, as in many other places, I was surprised to find absolutely a beautiful river with verdent intervals of rich alluvion, half a mile to two miles wide, within 20 miles of Cincinnati; and yet I had never heard of it. Indeed, with the magnificent Ohio, itself a tributary, and the beautiful Miami before us, we overlook the fourth grade of streams which in other countries would be a Tiber, an Avon, or an Isis. Mr. John Knox has on Indian creek, a farm one mile long and half a mile wide, which for fertility and neat cultivation would excite admiration in any part of the world. It is mostly a level alluvion, ("bottom land,") but the green hill rises rapidly on the west, and at the height of 40 feet gushes out with numerous copious springs, which cross the road, and form a streamlet on its opposite side. Along the channel of Indian creek, we observed that there was abundance of gravel only partially rounded, and very suitable for the construction of such a road as the Hamilton and Eaton turnpike. Near Oxford, on a hill, I observed water-laid sharp sand, which contained lime enough to be effervescent. The city of Oxford is on a hill, a beautiful swell from the surrounding plain, commanding a very extensive horizon. The colleges have a contiguous enclosure of "wild woods," with all of their grapevines, all perfectly western and in good taste; no affectation about them. Prof. Scott accompanied us to the colleges, to the library, the cabinet and the laboratory, all of which are creditable beginnings.

The hill of Oxford itself consists of the blue limestone, in place, covered with some feet of soil. The plain surrounding it, has more or less of diluvium or ancient alluvium spread over it. Immediately at the foot of the hill at a steam mill, a well has been sunk, perhaps 30 feet, which passed through a bed of tough diluvial clay marle, containing gravel and sharp fragments of primitive granite trap and secondary limestone rocks.

Oxford to College Corner, 6 miles.

In this route we passed over the level terrace of the country, crossing a few very small streams, the head branches of Four-mile creek.

In some of these, the blue limestone shows itself in thin nodular layers. In one a stratum a foot thick has been opened containing nodular fossils. It is bituminous. Small boulders were not unfrequent. The soil is clayey and fertile, and the frequent showers had rendered it almost bottomless mud. College Corner is a village which has sprung up within three or four years, and is situated exactly at the northwest corner of Butler county, and of course on the State line, which runs through a brick store. Small as the village is, it occupies a part of two States and of three counties. Butler county is abundantly watered by the Great Miami and its numerous tributaries. Its surface is mostly on the sloping declivities of the blue limestone or on the broad bottoms which border the larger streams. In the former situations, the soil has a substratum of loam, clay marle, and rocks; in the latter, the soil is sustained mostly by a bed of gravel, originally *diluvial*, but now by being washed from its place of ancient deposit, has become *alluvial*. Agriculturally, it is one of the most fertile portions of the earth, the hills being fertilized in a manner already described by the marl, and the valleys or bottoms by calcareous sand and annual inundations. In consequence of the gravelly substratum, the "bottoms" are apt to suffer more from drought than even the highest hills.

Geologically, Butler county is a unit. It all belongs to the blue limestone, and presents no variety, one section answers for the whole, and that for the Ohio at Cincinnati, is in general, applicable to every part of it.

The point of the journey of Dr. Owen and myself was to determine whether there be an anticlinal axis on the confines of the two States from which the rocks dip in opposite directions, but I have nothing to say on that subject in this place.

It is true, there is yet a labor to be performed in Butler Co., in tracing out the ephemeral alluvial deposits of loam, sand and gravel, and the bottoms of swamps and lagoons, and perhaps some diluvial coverings. From a greater portion of these, I was excluded by the high stage of the water, during my stay in the county. And these small local deposits require more time and and local observation than the State probably contemplated in the organization of the survey.

The geologist might almost as well look for variety and discoveries in examining the uniform layers of bricks and mortar in the walls of a building, as in the examination of Butler county. And yet indirectly in its

inexhaustible fertility, that county has the richest gold mines in the world.

Journey through Preble and Montgomery Counties, in order if possible to determine the dip.

I have already given an account of the cliff limestone at Ratcliff's, in the north part of Butler county. From that place, I proceeded after dark 5 miles to Camden, where my friend Erwin did not find it difficult to induce me to partake of his hospitality for the night.

Although it is considered nearer to the general deposit of the cliff limestone than Ratcliff's, yet it is at a lower level, and shows nothing in its neighborhood but blue limestone.

In the morning, Mr. Erwin accompanied me to the most interesting points in the neighborhood; the first of which was about a mile northwest of town in the bank of a streamlet where a person had been digging for coal! I found the ground along the stream full of foreign minerals, granite, gneiss, sienite, greenstone, and even primitive lime boulders, being abundant. The place itself had nothing in situ, and was both diluvial and alluvial. *Diluvial*, so far as it contained boulders, which must have been transported from remote regions, perhaps from beyond Lake Erie, the nearest point where similar rocks are found, and *alluvial*, so far as those materials had been washed down, and imbeded as they are by the contiguous "run" or rivulet. Nothing could be more geologically absurd than to dig for a *stratum* of coal, a *coal mine*, in such a place. The digging had been made in a gravel bank formed by the stream; where, amongst a mass of foreign materials, a little coal had been found. The same causes which had brought the granite, probably brought the coal. The only reason why it should not, is that, from its tender nature, it does not well sustain the violence of such removals, but becomes pulverized and dispersed. Insulated masses of coal are often found in gravel banks, and are no more an indication of the proximity of a coal mine than would be the same quantity scattered from a coal cart. One great use of geological information is to prevent useless enterprises, and tell people where treasures are not to be found.

It is some confirmation of the iceberg theory of boulders, that in the same vicinity we find a predominance of one kind as if they had all been brought from the same locality, or from the same rock. The prevailing boulders found to day around Camden have been a gneiss rock, traversed by layers or bands of red feldspar. One large boulder near the "digging," was composed of quartz containing a little mica and filled with small garnets. Another near was equal, I judged, to a globe 5 feet in diameter, and must have weighed 4 or 5 tons.

At a bluff, three-fourths of a mile from the mouth of Paint creek, we had a good opportunity to examine the layers of limestone in place. The bank rises at an angle of forty-seven degrees to the height of the general table in this neighborhood, which is about 70 feet. A spring, which originates on the top of the strata, had washed them bare like a flight of stairs, from top to bottom. After observing the baro-

meter at the bottom to stand at 740.6 millimetres, I ascended and found the whole to be of the blue limestone series, consisting of very thin layers, generally from 1 to 3 inches of stone, alternating as usual with layers of marl. At the top the barometer read at 738.7 millimetres, which corresponds to a height above the place of previous observation of 67 feet. It is my opinion that no other than the blue limestone occurs in place in the vicinity of Camden, a formation which in this country has never been found to contain coal. Indeed at least eight hundred feet of rocks, in perpendicular height, occur between this point, (the top of the blue limestone,) and the "coal measures." See report on Adams county.

Paint creek is a rapid and a copious mill stream, though it "goes dry in the summer." Its bed is covered with thin limestone, say one foot in diameter, lying like shingles, lapping down stream, exactly as if they had been placed there to receive the current, and protect the bottom from its action. Among and underneath them is some primitive gravel and quartzose sand mixed with limesand, so as to effervesce briskly with acid. The bank of this and of neighboring streams, so far as they are alluvial, or have been formed by the streams themselves, consist of gravel composed of broken limestone not entirely rounded, primitive gravel perfectly rounded, and sharp sand mixed somewhat with marle and loam.

Cyathophylla, ("petrified calves' horns,") are extremely abundant in the upper layers of the blue limestone. I counted 30 in the surface of a square yard.

Camden is a pleasant village on Four Mile creek, and about three fourths of a mile above the mouth of Paint creek. It is situated on the "bottom," and not more than 25 feet above the level of the adjacent stream. It has a Presbyterian and a Methodist church, and a dictrict school house, each with a cupola. The bottom and banks of Paint creek abound with the light green marle, which the Indians used to employ in painting their bodies, and hence it is presumed was derived the name of *Paint* creek.

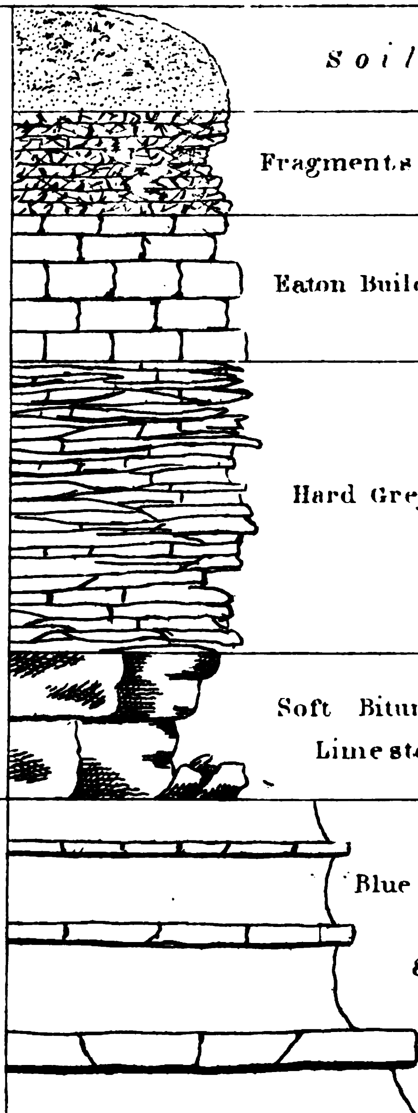
After dinner I took leave of Mr. and Mrs. Erwin, and proceeded towards Eaton, which is 6 miles distant. My route lay along the valley of Four mile creek. For four miles nothing but the usual appearances of the upper layers of the blue limestone formation was observable. Two miles south of Eaton, on the east side of a creek, and just below a mill dam. a bluff bank shows the cliff limestone, the green clay marle, and the blue limestone underneath it—one of those happy contacts so delightful to the geologist. Here I had a point exactly correspondent to that at Ratcliff's, in Somerville, 9 miles distant, and its height would furnish me with a line on the plane of the stratification. This point is 513 feet above low water at Cincinnati, Ratcliff's being 601. The difference is 88 feet. The distance is 9 miles, and the course about north 5° east. The surface of the blue limestone descends 9.77 feet, nearly 10 feet per mile, in the above course and distance.

I crossed the stream and made a particular examination of the sec-

No. 4

SECTION of rocks at Haldermans Mill, 2 mile S. of Eaton in Preble Co.

BY JOHN LOCKE.



NO	Feet		
I	2	CLIFF LIMESTONE	Soil
II	2	CLIFF LIMESTONE	Fragments of Stone
III	3	CLIFF LIMESTONE	Eaton Building Stone
IV	6	CLIFF LIMESTONE	Hard Grey Limestone
V	3	CLIFF LIMESTONE	Soft Bituminous Limestone
VI	13	BLUE LIMESTONE	Blue Limestone & Marle
Total	29		

tion which the bluff presents. Proceeding upward in the series I found at the water's edge the blue limestone in layers 2 to 4 inches thick, interlaminated with green clay marl, 18 feet. Above this lies the same soft course crystalline limestone found at Ratcliff's. On striking it with a hammer to detach a specimen, I perceived distinctly the odour of bitumen, petroleum, or rock oil, a smell similar to that perceived from burning bituminous coal. The broken surfaces were of a dark brown color. I have since learned that petroleum has been collected from cavities in the rocks, by the quart even. This soft stratum is 30 to 36 inches thick and breaks massively by perpendicular fissures, often exhibiting seams and cavities which have been partially or entirely filled by lime incrustations, deposited from infiltrating waters, such as are found in caverns, and are called *tufa*, or *stelagmites*. Immediately above the soft stratum and in contact with it occurs a stratum about 6 feet thick, of hard grey limestone in thin layers, more or less solidified together and without marl, precisely the same as that forming the "cavern," one mile north of Ratcliff's. It is not seen immediately on the bank, but a few rods up a small run it forms a little cascade, where Niagara-like, the soft layer below has fallen out, and permitted this hard layer to overhang in a "table rock," over which the stream takes a grand leap of six feet, and dances merrily down the stair-like slope formed by the marl and blue limestone below. Within a mile from this locality, immediately on the river bank, is opened the quarry of the Eaton building stone, (Halderman's quarry.) The stone is fine-grained, compact, not crystalline; but earthy in its fracture; nearly white, with a tinge of blue, spare of fossils, and effervesces very feebly with acids. It is composed of lime and probably of allumina and silex, in a state of minute division. The layers have a very even surface, and are generally not over 10 inches thick. The pieces into which it naturally breaks by vertical fractures are of a large size. It well deserves the name of building stone, being very suitable for architectural purposes. Its greatest fault is that the layers are not thick enough for some massive works. Underneath it there is a grey limestone which I presume to be identical with that described at the cascade, extending quite across the river, forming its bed and creating a rapid. I have ventured in the following section to superimpose the building stone upon the layers of the bluff at the mills below. (Plate No. 4.) At Easton, Four-mile creek makes several successive leaps of 2 to 4 feet each over layers of the cliff limestone, some of which are extremely porous and spongy in their structure, and abound in casts of a very large bivalve shell.

At Eaton I was very politely called upon by Doctors Baker and Paramour.

Eaton to Dayton, 24 miles.—From Eaton to Dayton, the road holds a due east course, following a section line. The first four miles are distinguished for the immense number of boulders, which almost cover the surface. They are from 6 feet in diameter downward, and consist

of all the different kinds of primitive rocks, such as sienite with rose feldspar, horn blende rock, green stone, sometimes porphyritic, trap-rock, primitive slate, primitive limestone, horn stone, and even the harder kinds of the trasition rocks; hornstone-like rocks containing rounded pebbles of quartz and red feldspar. In all of these, very little mica appears, but hornblend is abundant; some rocks are nearly pure feldspar, generally rose colored. Although this road runs over a high part of the State, being about 600 feet above the Ohio at Cincinnati, yet from its being level and clayey beneath, the water collects in every slight depression, and springs are thrown out at the surface, giving certain portions of it a marshy appearance, and exciting an impression common enough, that the land is "low." As the road runs a due east course, on a township line, these wet places had to be traversed without compromise. To prevent the road from becoming bottomless with clay mortar, the boulders have been collected to form causeways; a row of larger ones being placed as a wall on each side, and the intermediate space filled with stones about a foot in diameter. I presume they must formerly have been covered with earth, but that being trodden into soft mud in wet weather, had washed away and left the bare stones, a most uncomfortable pavement for every vehicle with wheels.

Within nine miles of Dayton, on the property of Mr. David Bick, there is a chalybeate spring, not copious, but well charged with iron. At this spring the barometer was noted as follows:

May 14, 1838, 12 A. M., 740.3 millimetres; 24° centigrade. At Mr. Bick's I saw more of the "building stone," and was told that it was quarried near. Advancing two miles further, I crossed a stream, in the bed of which was the blue limestone; and was told that the cliff limestone occurred about a mile above, or to the north, in the bed of the same stream.

At a tavern on a hill, 18 miles from Eaton and 6 miles from Dayton, the barometer stood at 737.7 millimetres; 25° centigrade.

From Camden to Eaton, and from Eaton to Twinfork, the sugar tree seems to give place to the beech. From Twin to the descent to the Miami, the sugar tree seems gradually to be replaced, and on the descent I saw the same kind of fine sugar orchards noticed above Hamilton. Arriving at Dayton I took lodgings at the *National* Hotel, a very respectable house, where the name *national* is less inappropriate than to two taverns in the woods between this and Eaton, and three or four between Dayton and Columbus. Almost every log shanty with a whiskey cage in the corner, is denominated "United States Hotel," or "National Hotel." Although this is not geology, yet the being compelled often to lodge at a nasty drunkery, nauseated with tobacco smoke, and kept awake by nocturnal bacchinals, had much to do with the comfort of a geologist, and his being sufficiently refreshed to be able to continue his laborious duties.

Early in the morning of the 15th of May, I visited Col. Partridge's quarry, 3 miles S. E. of Dayton. Here my object was to ascertain the height of the junction of the blue limestone and the overlying or

cliff strata, which junction, on a visit to this quarry in March, in company with Col. P. and Mr. Vancleve, I had found to occur here. In approaching the quarry I ascended the channel of a "run" to an outcropping of the blue limestone where the barometer stood at 744.9 millimetres; temp. 28° cente. From this I traced the clay marl up to a lime-kiln where the barometer read as follows:

743.9 millemetre; temperature, 28 centigrade. At the top of the bluff above the lime-kilns 742.8; temp. as above. At the quarry, in a few minutes after, 742.2 mill.; temp. 28.5 centigrade. Descending as rapidly as possible to my room in the hotel, the barometer read at 746.5 mill.; temp. 28.5 centigrade.

These observations would give approximately by adding 45 feet for the height of the room above the level of the Miami canal at Dayton, the following results;

Top of the blue limestone above canal	96 feet.
Top of the marl	134
Top of the bluff	177
Top of the quarry	193

The top of the blue limestone, or rather of the blue marl belonging to it, is then 476 feet above the low water of Ohio at Cincinnati. I have now obtained the elements of the Dip, which are as follows:

At Ratcliff's the height of blue limestone	601 feet.
At Halderman's, north 9 miles from last station	515
At Partridge's quarry, east 25 miles	476
Near Troy, north 20 miles	364

From Ratcliff's to Halderman's the line descends 86 feet, or at the rate of 9½ feet per mile. From Halderman's to the Dayton quarry, east 25 miles, the descent is only 39 feet or a little more than 1½ feet per mile. From the Dayton quarry to Troy, 20 miles north, the descent is 112 feet or a little more than 5½ feet per mile, being 5 and 6 tenths. From these data it is evident the dip is not quite uniform. An average would give the following results: North 29 miles, a descent of 198 feet; east 25 miles, a descent of 39 feet.

Line of bearing, or that line in which the strata lie level, E. 14° S.; and the line of dip, or that line in which there is the most rapid descent, north 14° east; at the rate of 6 feet per mile.

Col. Partridge's quarry lies on a table or terrace, nearly 200 feet above the level of the canal in Dayton. The rock is covered with from 2 to 5 feet of soil, which bears a forest of large oaks. The soil and the surface of the quarry beneath it, descend at a slope of one or two degrees in all directions, from a central or elevated point of convexity. The useful stratum is only about 4 feet thick, and is separable by seams, into at least 5 portions, as follows:

1. A stratum about 8 inches thick—in some places entire, in others broken and partially dissolved, there being large tubular channels be-

tween the pieces, as if a stream of acid had flowed along and corroded a passage for itself.

2. A layer 5 to 6 inches thick. The surfaces of this layer, although in general true, are not smooth, having indentations and sharp prominences of about an inch. This layer is fitted to the third as if it had been moulded or cast upon it; a prominence in the one entering and fitting a corresponding cavity in the other.

3. A layer 20 inches in thickness being the main and thickest layer. This layer has 5 visible and parallel seams dividing it into 6 portions, but is not inclined to separate at more than one of them, when it resolves itself into one layer of 8, and another of 12 inches. Indeed there are 12 or 14 lamina, like the leaves of a book, visible to the eye.

4. A layer 3 to 4 inches thick.

5. A layer 12 inches thick.

The whole quarry is cracked into tables of various forms by vertical seams. The largest piece which I saw measured 25 feet in one direction, and 18 in another. The seams are generally close, but in some places they are opened 8 to 12 inches, occasioned probably by a change of the stratum from a level to a convex form, either by a pushing up of the middle, or by a settling of the edges. This stone is nearly white, having a slight shade mixed with yellow, very compact, semi-crystalline, and sparkling, of a fine grain and almost flinty or chonchoidal fracture. It is nearly pure carbonate of lime, as appears from my analysis of it made in 1835. One hundred grains were found to contain the following substances:

	GRAINS.
1. Carbonate of lime	92.40
2. Protoxide of iron	0.53
3. Matter insoluble in mur. acid	1.70
4. Carbonate of magnesia	1.10
5. Silex from solution	0.90
6. Small crystals of iron pyrites	0.10
7. Water, &c. expelled by a red heat	1.08
Loss	2.19
	100.00

Were it not for the seams already mentioned, it would make a very fair marble. It is still one of the best building stones which our country affords, and possesses all of the stability and durability of marble. Its beautiful light color is liable to suffer from the weather, by the decompositon of iron pyrites which occurs in some parts of the stone, communicating a rusty stain. The soil above the rock is imbued with copperas from the same decomposition, and precipitates the astringent juices of the cut roots of the oaks, black as ink, marking each one in the cut bank of the excavation, with a large surrounding stain in the earth. The stone contains, in this situation, few fossils. There are upon the surfaces of the layers large rings in bass relief, the interior

diameter say 3 inches, and the exterior 9, rising in relief one inch. They are extremely compact and fine grained in their substance, having no tubes or pores. Some of them are not annular, but are hemispherical. Are they corallines?

The quarrying is conducted by "stripping" the stratum of the forest and soil which cover it, breaking the layers by wedges into portions of suitable size, and lifting them out by cranes furnished with blocks, pulleys and cables, drawn by ox teams. The cranes are ingeniously attached, successively, to an undisturbed oak tree on the contiguous unbroken bank. The stones thus raised are loaded on wagons and drawn to Dayton, where there is an extensive stone yard or depot, from which they are shipped, either wrought or unwrought, by way of the canal to their destination. I believe the proprietor charges at the quarry, 12½ cents per perch for the privilege of quarrying. This is a moderate price; and yet allowing the quarry to be 4 feet thick only, it will amount to 880 dollars per acre. With a sufficient demand for the stone, this would not be a bad gold mine. It is a curious geological fact, that the upper surface of the quarry, especially at the apex of its convexity, has the roughness already described, nearly worn off, not by corrosion, decomposition, nor by the atrition of sand and gravel, but by the grinding of a flat surface, making the work, so far as it went, a perfect plane, and leaving the pits of the deepest cavities entirely untouched. My attention was first drawn to this subject by Mr. John Vancleve of Dayton. Some of the thinner layers of the stone are used for flagging stones, and the pitted surface with hemispheric and annular embossings, are well seen in the Dayton sidewalks.

Underneath the quarry is a softer, coarsely crystalline limestone, of a reddish drab color, sometimes variegated with blue. It is abundant in fossils and receives a good polish. Mr. Vancleve has prepared some beautiful specimens from it. It abounds with a skinny kind of fossil, called by Goldfus, eschara. At about 7 feet below the quarry stone, it is soft, but still crystalline. It seems to me to be the stratum of "soft limestone" found at Ratcliff's, and at the mill below Eaton. The fossils are similar. The quarry stone I conceive to be the equivalent of the cliffs found one mile north of Ratcliff's. See Nos. IV and V, section 4.

The following information was procured from Mr. Forrer, State engineer:

Lockage from low water of the Ohio at Cincinnati, to Piqua.

Low water of Ohio at Cincinnati to the upper plane of the city,		110 ft.
Lockland	40 ft.	150
Hamilton	20	170
Middleton	42	212
Franklin	38	250
Miamiesburg	17.5	267.5
Dayton	31.5	299
Light's	53	352
Troy lower level	39	391

Surface of blue limestone, 27 feet lower···· ··············· 364 feet
Piqua upper level, 36 feet······································· 427

Light's Quarry,

Mr. Light's quarry lies on the east side of the Miami and 7 miles above Dayton. It is nearly on a level with Col. Partridge's quarry—furnishes a similar kind of stone, and has similar rocks and marl beneath it. A section at this place would be almost identical with that at Col. P's.; but the useful layer of the quarry is probably considerably thinner.

At the top of Light's quarry, May 16, 11 A. M. 1838, the barometer stood at 740.2 millimetres; temp. 29° Centigrade. At the canal near Light's quarry, 743.6 mill. temp. 29°. This would give, for the approximate height of Light's quarry above the canal, 96 feet, or 448 above low water at Cincinnati; 28 feet lower than Partridge's quarry. The quarry was rendered particularly interesting by the discovery in it of "diluvial grooves," a circumstance which I had thought probable from the fact of the planishing, or grinding down of the strata pointed out to me by Mr. Vancleve, at Col. P.'s quarry. Light's quarry has been stripped of soil, more or less, over 10 acres, and the upper layer of stone is in most places completely ground down to the plane, as perfectly as it could have been done by a stone cutter, by rubbing one slab on another, with sand between them. In many places, in addition to the planishing, grooves and scratches in straight and parallel lines, evidently formed by the progress of some heavy mass, propelled by a regular and uniform motion, are distinctly visible. All this is the more remarkable, as the natural surface of the stone is, within certain limits, as rough as can be conceived, there being sharp teeth an inch long projecting from one layer, and entering the contiguous one. In some places this roughness was entire, in others the prominences were just touched by the grinding operation, partially worn down, or entirely obliterated, leaving a flat plane, but unpolished surface. These circumstances leave no doubt of the original rough nature of the surfarces. The grooves are, in width, from lines scarcely visible, to those three fourths of an inch wide, and from one fortieth to one eighth of an inch deep; traversing the quarry from between N. 19° to N. 33° west, to the opposite points, in lines *exactly straight*, and in fassicles of sometimes 10 in number, *exactly parallel*, cleanly engraved in compact limestone, without seam or fault of any kind, and in a surface ground down to a perfect plane, suitable for a sideboard or a table. The evidences that the grooves had not a recent origin, are,

1st. The quarry was covered with a loam 2 to 8 feet thick, bearing large white-oak trees. 2d.—The grooves were straight, while recent scratches, formed by the operations of quarrying, were always more or less curved and crooked. 3d—They contained little patches of tufaceous crust, formed, apparently from the impalpable powder generated by the grinding, and never exhibit by friction, by the nail, any recent dry loose powder, which always shows itself in the recent

scratches. 4th—They extended under the soil which had not been disturbed before I made the examination. 5th—They were all nearly in one and the same direction, N. 26° W., while the operations of quarrying were nearly at right angles to this course. 6th—Some of the larger grooves were deeper and broader than any movements of teams on the quarry could have produced, and were at the same time corroded at the bottom. 7th—No mechanical operation to which the quarry had been subjected, could have ground down the rough stone to a plane. This flattening of the surface seems the most difficult to account for. Have superior strata been removed by some horizontal force, which slid them across this surface? The grooves appear as if they had been formed by icebergs floating over the terrace, which is the highest in the neighborhood, and dragging gravel and boulders frozen into its lower surface, over the plane of the stone. The rectilenear course of these grooves corresponds with the motions of an immense body, the momentum of which does not allow it to change its course upon slight resistances.

It is impossible to account for the phenomena by supposing them to be the effect of *alluvial* action. The motion occasioned by a river, may wear a surface in general smooth, but not to any extent to a perfect plane. It may roll stones or slide them along, but seldom if ever so as to engrave lines so perfectly straight and parallel.

In order to give a specimen of these grooves a chance to speak for themselves, without the imputation of exageration by pen or pencil, I have brought into requisition a new art—that of "medal ruling." With the assistance of Messrs. Doolittle & Munson, I have put the specimen into their excellent engine, and suffered it to engrave its own picture, and thus stop the mouths of faultfinders. In the annexed engraving each line is a true section of the surface over which the "tracer" actually passed. Pl. 2, fig. 1, represents a portion of two fascicles of grooves of the natural size. The first fascicle bore N. 31° W., and is that which is most conspicuous. Of the second fascicle there are only two lines, marked N. 26° W, apparent in the specimen. These lines are perfectly straight, and, within the same fascicle parallel also, while the accidental grooves, formed by the operation of quarrying, as k k, are curved. The letters d d d mark pits; l l, patches of tufaceous crust; e e e, places in the grooves where the stone scaled up in angular fragments before the sharp point which formed them, an action technically called chattering. These marks show the *direction* in which the moving force acted, to have been from the northward to the southward. The dark line a b shows the profile of the surface to be nearly straight, with the exception of the depressions of the grooves. Fig. 2 is introduced out of place to show the tufaceous crust in the groove a b c. Fig. 3 exhibits at A B a section of the same stratum unpolished; such a surface as that of fig. 1, is supposed originally to have been. The shading under fig. 3, shows the effect produced by "ruling" over the rough unground surface of the stone.

I deem it proper here to observe, that I did not come to the conclu-

sion that the above described grooves were ancient or "diluvial grooves" without caution and particular examination. I took pains to re-visit the quarry twice in order to settle queries which by reflection had arisen in my own mind. By turning to Prof. Hitchcock's report on the geology of Massachusetts, the reader will perceive that diluvial grooves occur in the primitive rocks of that region not unlike those which I have found in our limestone. But I did not recur to the description of them until I had written the above, which was copied from the book of nature alone.

The upper and planished layer of this quarry is only from 2 to 4 inches thick, and well calculated for flagging stones. Their introduction upon the sidewalks of Cincinnati would add much to the convenience of that city and remove those dilapidated monuments of fraud, the *soft* brickbats, sold and laid for paving bricks. Yet these marble slabs have been broken up to build rough cabin chimneys and cellar walls in the neighborhood of the quarry.

The stone immediately below the quarry is the "soft limestone," broken and worthless except for the limekiln. It crops out just below the quarry, where commences the descent to the valley of Miami, and is at least 25 feet thick. Below the soft limestone are 30 or 40 feet of marl, which seems to extend to all parts of this neighborhood, and is the water bearer, throwing out springs at its upper surface. A copious one flows underneath the *out-cropping* just mentioned.

Dayton to Troy, 20 miles.

From Dayton to Troy the bed of the Miami is in the blue limestone, and its valley is bounded by the cliffs of the cliff limestone, over which the small tributary streams are projected in picturesque cascades with a perpendicular leap of about 30 or 40 feet. At 7 miles above Dayton the canal crosses the Miami from the east to the west side of it, by an aqueduct. Here the road is compressed between the canal on one side, and a bluff, surmounted by a mural cliff, on the other. The cliff limestone having the thick layer of marl underneath, it is easily undermined and falls down in large fragments, forming at this place a talus of 150 feet on the slope. Within about a mile southwest from this point is Mr. George Fryeback's quarry. The quality of the stone is similar to that at Col. Partridge's, but the strata being thinner and the joints more open, it is less fit for fine purposes. The upper surface of the stone is not at all ground down, but is covered by a silicious limestone. evidently a continuation of the stratum which furnishes the Eaton building stone. It is hard, scarcely effervescent, has a dry earthy fracture, and is of a light drab color. The layers are from one to two feet thick, broken into small pieces, and worthless; yet I was happy to find its place in the series of stratification. The barometer at Fryeback's quarry, 7360. Temp. 21° centigrade. At the canal a few minutes afterwards it read 7393. Temp. 23°. This would indicate a height of the quarry above the canal of 104 feet; or

above low water of the Ohio, 456; being 20 feet lower than Col. Partridge's quarry at Dayton.

Cascades.

The road towards Troy finally winds up the face of the cliffs and attains the upper table or terrace, the level of the quarries. At 9 miles from Dayton, and at the point of intersection of the National road with the road to Troy, and with the cliffs, some very pretty cascades occur by the passage of small streams over the out cropping edges or overhanging tables of the cliff limestone.

At the principal cascade, which is precipitated, dangerously enough, from the very road itself, the perpendicular leap is 32 feet, and including the slope of the rocks immediately above and below would be 45 feet. The stream at this time was sufficient to turn an overshot mill, discharging about 400 gallons per minute. Although but a minature, this cascade is a picturesque and interesting object, almost identical however with several others in the neighborhood, and very similar to all others in the world, where they are formed by streams falling over the edge of stratified rocks lying on softer materials as shale, marl, clay or sand. It is a Niagaret; the stream running over an elevated table of bare rocks almost without banks, drops suddenly into a "horse shoe" shaped gulf which it has created for itself. The immediate leap is from a table rock not more than a foot thick and 10 feet broad. The cavern-like distance from the falling sheet back to the rocks is 23 feet. In this recess, a person having attained the lower part of the gulf by a circuit, walks leisurely round underneath the fall on an under bank or talus of fallen and broken rocks and marl, which slopes rapidly towards the falling stream as a centre. This bank is arranged like the seats of an amphitheatre, while the cliff above is like a part of a dome covering it. Were the water away the place where it strikes would be a fine stand for a lecturer or demonstrator, who might have a thousand hearers on this underslope, and as many more on the top of the cliff as a gallery. The circumference of the walk around under the fall is about 300 feet.

The lower stratum in the cavern of the cascade, consisting of about three feet, is partly sedimentary, containing fine sand and argillaceous matter. The frost acts upon it so as to split it off vertically in slabs, or board-shaped prismatic pieces; one of these was one inch thick, six inches wide, and three feet long. When partially decomposed, it appears meagre and earthy; but when freshly broken, it has crystalline appearance, and exhibits a feldspar-like gleam in the light. It effervesces slightly with acids. This formation, which is here in rudiment, as it were, is developed at Madison, Ia. and in West Union, Adams county, into a quarry of no small importance. It is probably a water lime. The water, which filters through the rocks at the cascade, seems to be highly charged with lime; as it drips from the clefts between the overhanging rocks and falls upon the bank below, it forms, on the left hand side, a pile of "petrifaction" calcareous tufa, three or four feet high, with a peculiar corrugated surface, like the

exterior of the brain. Where the dripping originates, a moss grows upon the wet rocks, and becoming incrusted by the petrifying quality of the water, falls down in curious petrifactions below. At a spring which comes out of the cliff below the cascade, masses of leaves and small sticks are encrusted with lime by the same petrifying quality.

Peculiarities at Mr. Halderman's.

It is only about half a mile from the cascade just described, to Mr. Halderman's, whose farm shows that an excellent soil covers the cliff stratum. Mr. Halderman accompanied me to the bluff descent towards the river, and the outcropping of the cliff at the same place, where he had quarried the underpinning of his barn, which he called sandstone. It is a thick stratum of the soft limestone, having an arenaceous texture, and a full red color, and every appearance of a coarse red sandstone; indeed, the particles seemed to have the sharpness of quartzose sand. To determine the point at once, I powdered some of it, laid it on a piece of bark, and poured a little acid over it. The whole dissolved rapidly with effervescence. It is a crystalline limestone, of so loose a texture as to be easily nibbled to pieces with the fingers. Being easily quarried and shaped for building, and hardening by exposure to the weather, which it endures without injury, it is a convenient material for rural structures. Unfortunately it lies near the bottom of the cliff, which is 30 feet thick, and is therefore difficult to quarry. Mr. Halderman has taken advantage of the upturned fragments which form the talus along the bluff, and obtained so much of the stone as answered his purpose well without inconvenience. A little north of Mr. Halderman's is another cascade, very similar in appearance to the one just described.

Flinty Limestone.

Advancing towards Troy, I met with nothing peculiarly interesting till I came within three miles of that place. Here the same stratum which occurs at the cascade has been opened and worked. A streamlet which runs through the quarry exposes the strata for some distance below it. Immediately below the cliff is a drab-colored marl, which, on descending, changes into a clear blue, and has a thin layer of blue stone which scarcely effervesces. The marl at this place is less effervescent than I have usually seen it. About fifteen feet below the bottom of the cliff, there occurs a stratum which I had never seen before. It is only five or six inches thick, and in the midst of the blue clay. It consists of rather nodular masses of flinty limestones, having a flint-like conchoidal fracture, affording splinters with sharp edges; the general color is dark drab, but variegated, especially about the centre of each nodule, with white transparent crystals of pure carbonate of lime. It is but slightly effervescent. This is, I presume, the reputed "marble" of this locality. The masses here are too small, and too hard to be worked, for a marble; they may be larger elsewhere. I descended still farther to find the blue limestone, but found the banks obscured with soil and alluvion. After collecting the proper number

of specimens of this flinty limestone, and some specimens of the columnar limestone, which occurs in the cliff above, I proceeded to Troy, and returned on the east side of the Miami, to Dayton. This flinty limestone is found more fully developed in Indiana, about Cross Plains and Versailles In some form or other, silicious formations show themselves between the blue and the cliff limestone. The blue limestone disappears under the bed of the Miami Canal, a little below Troy, where it is covered with a dark marlite, as it is at Madison and at Richmond, Ia. This marlite is so intermediate between earth and stone that it has given rise to some litigation in contracts for excavation. As it requires blasting to remove it most expeditiously, it has, I believe, been usually classed as stone.

A cascade and a chalybeate spring on the east side of Miami, near West Charlestown.

In our journey from Dayton to the Charlestown cascade, Mr. Vancleve and myself called at the hotel of Mr. Wright, near the intersection of the national road with the road on the east side of the Miami. Here we examined a chalybeate spring which has every appearance of being one of excellent quality. The water is remarkably transparent, has an agreeable chalybeate taste, emits occasionally bubbles of gas, and deposites a yellow or rust-colored sediment as it runs off and becomes exposed to the air. It discharges about ten gallons of water per minute. I see no reason why this should not become a "watering place." But for the unfortunate circumstance that the cascade goes dry during the hot season, it would be an additional attraction to the spring as a place of amusement. We advanced, accompanied by Mr. Wright, and when we had come within sight of West Charlestown, we turned to the left through the woods along the stream which forms the cascade, say half a mile, on a gradual and uniform descent to the cliff at the edge of the Miami valley, over which the water leaps forty feet, into the ravine below. This is another Niagaret, and has worn for itself a "horse shoe" in its "table rock." The clear leap is thirty-six feet, but there is a rapid of four feet along the upper table.

This cascade differs very little from that previously described. It is larger, and the water instead of falling upon rock rubbish at the bottom, drops into a beautiful pool. The table rock overhangs at this cascade even more than at the other, with an under slope at an angle of 30 degrees only with the borison, forming a cavern underneath the cascade receding 40 or 50 feet. At the extremes of the horse-shoe escarpment, the cliff becomes gradually perpendicular, and on the right or northern side has a cylindrical gallery 3 feet in diameter, entering just above the talus. At the mouth of this, is a pile of earth, mixed with numerous bones of small animals, some of which appear to be the vertebræ of the rattlesnake. At this cascade, the rocks, as might be expected, are nearly the same as at that on the west side of the river. The section would be as follows, beginning at the top:

1st. Eight feet of compact limestone in thin irregular layers, vari-

ously united, and having small crevices and cavities between them. Is this the equivalent of the quarrystone?

2d. About 8 feet of limestone more massive and granular, supposed to be the equivalent of the soft limestone seen at Halderman's, but is here much harder.

3d. Four feet of limestone abounding in argillaceous matter and fine sand. It is fissile and crumbles or splits by the frost, so as to undermine the rocks above. Where this stratum had been weathered, its fracture is meagre and earthy; but deeper, it is of a blue color and has a feldspathic gleam in a particular position, showing it to be in part crystalline. It effervesces but feebly with acids. I suspect it would afford water lime.

4th. Fifteen feet of blue marl highly effervescent.

5th. A thin stratum of the silicious limestone, similar to that found 3 miles below Troy on the west side of the river.

6th. Blue marl, perhaps 50 feet.

7th. Blue limestone.

Boulders in the vicinity of Dayton.

In company with Mr. Vancleve, I examined several species of boulders on a farm of his within two miles of Dayton. We found a blue, finely granular limestone, apparently primitive, many boulders of sienite and red feldspar; of hornblende slate, in one instance including talc, gneiss and mica slate; white granular limestone containing tremolite; and one boulder containing granets, tourmaline and black mica, the garnets and the tourmaline being well defined. I would here remark, that attention should be paid to these boulders, rather with the hope of ascertaining their probable origin than for the purposes of utility; for, although they may be converted to use, yet from their limited quantity, and broken weathered condition, they cannot be of much importance. Some of the sienitic boulders, so exactly resembling the Egyptian rock, might indeed be used for monuments of small size, but for such a more delicate stone would be preferable. The use of feldspathic boulders in the manufacture of porcelain, has already been mentioned.

Journey to Madison in Indiana.

Having become interested in the geology of the junction of the blue and the cliff limestone, I determined to trace it beyond the limits of Ohio. My friend Dr. Owen had informed me that it appears at Madison, and I proceeded thither to examine it. I fell in with the cliff limestone about 25 miles north of Madison, and found it to occupy the hill tops all the way to that town, while the blue limestone appeared in the ravines. At Cross Plains, the little silicious stratum seen 3 miles below Troy on the Miami, is developed into a fine building stone, which although hard, "spalls" or chips under the hammer, by the conchoidal fracture, with great facility. At Mr. Cooper's, near Versailles, is a cascade over the cliffs surpassing those on the Miami. The clear leap is 46 feet, and the

gulf or horse-shoe into which it falls about 80 feet deep; and 150 feet in diameter. A section at this place hastily sketched on the spot, was as follows:

1st.	Soil	3 feet
2d.	Chert or flinty fragments	1
3d.	Clay	12
4th.	Compact, proper cliff limestone	4
5th.	Marl	10
6th.	"Soft limestone" abounding with the eschuda	3
7th.	Marl	8
8th.	Flinty limestone	1 to 2
9th.	Lime and marl in thin layers	50

The flinty fragments mentioned as the second item of the section, are very abundant in this part of Indiana. They have originated from some stratum which once included them as nodules, but being decomposed has deposited them.

The stratification being very regular and in members in some degree equal, the walls of the semicircular abyss of this cascade assumed a beautiful and imposing symetry like a work of art. A full and magnificent cornice and frieze of a dome 150 feet in diameter, did not require to be imagined; it was really there in the solid masonry of the earth; each stratum forming in projection and altitude a member of the architrave. Those who wish to find a *natural* type for works of art, may there be gratified. Although the ancient architects never studied a cascade in Indiana, yet they had abundant opportunities of seeing similar cascades over similar rocks. This region abounds with large cauliflower-like and hemispheric fossils, which are externally silicious and often contain internally, clear calcareous spar, or are hollow and lined with crystals of dog-tooth spar.

At Madison, there is the finest developement of quarry-stone which has met my eye at any point in the west. The quarry consists of 42 feet of stone in layers of from 1 to 7 feet thick, with scarcely an inch of rubbish of any kind in the whole of it. At the price of 12½ cents per perch in the quarry, an acre of such stone would be worth 9240 dollars. The section beginning at top, is as follows:

1st.	Soil and proper cliff limestone, see section 3, No. 4.	20 feet.
2d.	Dark blue crystalline faultless limestone in 7 layers	15
3d.	Light colored earthy argillaceous limestone	5
4th.	Dark blue limestone	2½
5th.	Limestone	1
6th.	Limestone	2
7th.	Banded earthy argillaceous limestone	3
8th.	do do do do	2
9th.	do do do do	7
10th.	Earthy limestone	4
11th.	Blue marlite, say	50
12th.	Blue limestone	150

The items from 2 to 10 inclusive are almost faultless in their texture. A few of the argillaceous layers will not endure alternations of water and frost, but are still durable when once laid up in the walls of a building. I think I see in the above section, the equivalents of the rocks which I have described in Preble and Montgomery counties, though very much modified. The first 20 feet is the proper cliff stone. The 15 ft. of dark blue crystalline limestone, is the soft limestone found at Halderman's, and underneath the Dayton quarries. The 7th, 8th, and 9th, the banded earthy argillaceous limestone, is the equivalent of the earthy layers at the Miami cascades. The earthy limestone of Madison, is imperfectly effervescent, does not slake after burning, and yet contains more than 60 per cent. of carbonate of lime. Its powder dissolves slowly in muriatic acid, leaving a muddy mixture of fine clay and sand. Its calcined powder mixed with sand, hardens readily and firmly under water, and is undoubtedly a valuable Hydraulic cement. I am at a loss for a name for this sort of stone. It is popularly denominated bastard limestone, freestone, and sandstone. It occurs frequently as a lower member of the cliff series. There is a quarry of it in West Union, in Adams county.

For the information of those who may be inclined to make the investigation, permit me to observe that I shall not charge the State of Ohio my salary during this excursion beyond its limits, but as a sketch of the information would, I thought, serve to show the connection of our geological formations with those of an adjacent state, I have taken the liberty of offering it to the service of our citizens.

ADAMS COUNTY.

General Geological features, surface, &c.

The rocks of Adams county are so well defined and so various as to render it a model of stratification. It embraces a varied series, including different strata, extending from the blue limestone to the fine grained sandstone. These layers are represented in the section No. 6, and again in the general section of the county, placed at the bottom of a map of the same.* The strata are of nearly a uniform thickness, and nearly uniformly inclined east 9¼ degrees south, at the rate of about 37 and 4 tenths feet per mile, or a little more than one hundred feet in 3 miles. In the direction of north, 9¼ degrees east, a line on the strata or layers of rocks is level just as the sloping roof of a house, is level in a line parallel to the ridge or to the eaves. This is called the *line of bearing*, while the line at right angles to it, east 9¼ degrees south, is called the line of dip. If the rocks of Adams county were continued onward as they now lie, until they filled up the surface of that county to the height of 500 feet above the level of low water of the

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*A map from autherities reputed the best was furnished to me by Col. Whittlesey, Topographical Engineer; but in my explorations I found reason to prefer the map in the auditor's office at West Union, which I reduced and prepared for publication.

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Ohio, at Cincinnati, the several layers of rocks running up a slope from the east, and cut off by this level surface, would present at that surface several belts of various widths, running in the direction of the line of bearing. I have supposed such a surface, and have drawn faint lines on the map representing those belts of what are called the *out-cropping edges* of the strata.

If the county were sliced down by cutting off level horizontal layers so as to reduce it in height successively to 400, 300, 200 and 100 feet, it would still present the same belts of surface having the same width, but removed each time a little more than 3 miles to the east of the place which they formerly occupied.

The several layers of the rocks of Adams county, as shown both in the general section and on the map, are beginning at the bottom, as follows:

	Feet.
1st. Blue limestone of indefinite thickness	
2d. Blue marl	25
3d. Flinty limestone	51
4th. Blue marl	100
5th. Cliff limestone	89
6th. Slate	251
7th. Fine-grained sandstone	343

These layers lie over each other like shingles on the roof of the house; and if the county could be cut in two, as a carpenter would saw a plank, or as one would slice down a cheese by a vertical plane, in a direction nearly east and west, and the south part of it could be removed, the cut end of the north part would appear like the "section" at the bottom of the map. If the reader will take pains to lay the map of Adams county flat on the table with the lower end of the same projecting over the edge of the table about an inch and a quarter, to the dotted line marked 500 feet, and turn that projecting end down so it will show on the edge of the table, while the map lies flat on the surface, he will see in the "section" or turned down edge, a picture of this cut end of the county in true position, that is perpendicular, the height being 500 feet, only the rocks are not so steep in fact as they appear in this representation, the heights being 25 times too great for the distances. He will also see how the several layers of stone will be cut off by the surface, and form broad belts running in the line of bearing N. 9½ deg. east. If the whole county were sliced up into thin layers by sections running E. 9½ degrees south, they would all be nearly the same as that represented at the bottom of the map; and thus it appears that this "section" is "applicable to every part of the county." From the connection of this diagram and map, the following problems can be solved. If the height of any point in the county is given, the kind of rocks at that point can be ascertained; and conversely, if the kind of rock be given, the height can be found. For example, at a point on Scioto Brush creek, in the N. W. part of the county between the survey 2345, and that next east having the same

number, the surface was found to be 250 feet above low water at Cincinnati. What kind of rock would be found there? Follow down the *line of bearing*, a faint line passing the mouth of Stout's run, to the base line of the map, then with the dividers extended, by the scale at the end of the section to 250 feet, (five eighths of an inch,) measure upwards on said line of bearing, and they will reach to the top of the cliff limestone, which is the kind of rock seen at the place named. 2d example: At a run 2 miles west of West Union, the barometer gave me the height 450 feet; a peculiar stone is found there. What layer did it belong to? Follow down in a line parallel to the line of bearing to a point in the base line at 3½ miles, and measure upward 450 feet, (one inch and one eighth.) The middle of the flinty limestone will be the point. West Union stands on the top of the cliff limestone. What is the height? Follow down the parallel to the line of bearing, to the base line at 5 and one tenth miles, where the top of the cliff limestone measures 600 feet. The Court House floor at West Union is 543 feet, and the highest ground very nearly 600 feet. Such a section, and with such results, can be applied to any region where the rocks lie all in parallel planes, whether they be horizontal or not. The learned reader will excuse this particularity and elementary detail, for I suppose myself talking to a plain farmer of Adams county, who helps pay for the survey and has a right to have it explained to him intelligibly, and I know that *stratification* with all of its effects, so plain to the geologist, is not intuitively conceived by the uninitiated. I now proceed to describe the belts or "outcropping" edges of the several strata, supposing the surface of the county to be a plane 500 feet higher than low water of Ohio.

1st. The blue limestone would extend from the west into the south-west corner of Adams county, only about one mile; into the north-west corner about 4½ miles, where it would disappear under the marl and continue onward to the eastward, sloping deeper and deeper, no one knows how far.

2d. The blue limestone would be succeeded eastwardly by a belt or out-crop of the marl two-thirds of a mile wide.

3d. The belt of flinty limestone, one mile and one-third wide.

4th. The belt of the great marl layer 3 miles wide.

5th. The belt of the cliff limestone 2½ miles wide.

6th. The belt of the slate 6½ miles wide.

7th. The belt of sandstone occupying the remainder of the county and extending about 10 miles.

Now as the surface of the county is not level it does not actually exhibit such belts but only such an approximation to them as the surface is to a level. The western part of the county consists of blue limestone very nearly 500 feet high, as at Decatur, Fairview, &c. West Union and some hills 2 or 3 miles to the west of it shows the cliff limestone rising to 600 and 700 feet. The bed of Brush creek again is in the blue limestone because it is excavated to near the level of the base line, being only 20 or 30 feet above it. Cherry fork and nearly all of the branches about Winchester in the north-west part

of the county are also in the blue limestone and seem to descend on the regular slope of the stratification. Above the marble furnace the bed of the Brush creek is in the flinty limestone, and finally in Highland county, ascends into the cliff limestone. It will be seen that most of the tributaries of Brush creek are on the west side of it; those from the east being short and few in number. This results from the dip of the strata, and the natural surface conforming to it. The slopes to the east, on the inclined surface of the stratification, are broad and gradual, but those to the west are abrupt and narrow, being over the *escarpments* or upturned ends of the several layers. The cliff limestone, the marl and the flint limestone at West Union, are what are called outliers, a kind of geological island, as they are cut off on every side from the main body of the same layer and stand out above. They are cut off on the west by out-cropping, on the north by cherry fork, on the east by Brush creek, and on the south by the Ohio river, all of which have their beds in the blue limestone.

Some suggestions with regard to Geological Maps.

So far as I know, my map and section of Adams county are on a new plan, and afford an extensive application—a universal one indeed. It is evident from geometrical principles, that where strata are nearly uniform in thickness and lie of course parallel to each other, a section made in the line of the dip may be so connected with the map of a county as to be *universal*, not a section in one line merely, but a section in any one of all the planes parallel to the line of the dip. With such a map and section the interesting problems just described can be solved. The strata in Ohio do not on the whole lie in such parallel planes; but in the extent of a county they are sufficiently approximations to render the results of such a section useful. The survey of every county should be accompanied with a map of the same as accurate as circumstances would permit and on a uniform scale, which might be 2 miles to the inch, the heights in the sections being 400 feet to the inch.

Details of the survey of Adams county, containing an account of the sub-strata, and objects of particular local interest.

Having given the outline of the thickness, order, super-position, dip, out-croppings, &c. of the rocks in Adams county, I now proceed to the details of the sub-strata and objects of local interest.

In my journey from Cincinnati to West Union, I made barometrical observations at all of the most elevated points on what is called the ridge road through Withamsville, Bethel, Georgetown and Decatur. The result of which was, that the general table is nearly a uniform level, the various points differing not more than 36 feet from each other, being usually about 500 feet above low water at Cincinnati.

West Union, being on an escarpment of the cliff limestone, is near one hundred feet higher, overlooking the whole surrounding country

except some outliers, Baldhill and Cavehill, to the north-west, and the very elevated knobs of slate and sandstone east of Brush creek. As the great marl stratum underlies the cliff limestone, the descents from West Union over the cliff and the marl are very abrupt The marl being soft, and, during wet weather, treading into a bottomless mortar, requires the roads over it to be stoned. As the road towards Chillicothe, passing down the valley of Lickfork, descends in the course of 4 miles quite down to the blue limestone, I made, with the assistance of the barometer, the following section from West Union to Treberes, commonly called Driver's tavern: [*See Plate No.* 6.]

Soil at, and about, West Union.

The soil on the cliff limestone about West Union and along Gift-ridge to the southwest of the town, is nearly as fertile as the blue limestone region. The loam is from 2 to 10 or even 20 feet deep, producing hickory, oak, black walnut, ash, sugar-tree, dogwood, sasafras and gigantic poplars, (Liriodendron tulipifera,) which are considered the characteristic tree. The descent having only 37½ feet per mile, it appears to be level. In many places the soil on the cliff limestone is ferruginous and has a bright red color like that of burnt ochre, spanish brown, or venetian red. This appears at West Union. It is only between the heads of the streams in this neighborhood that the table of the cliff limestone shows itself in ranges of limited extent, scored in upon the sides by the precipitous ravines, uniformly produced by the springs which, at various points, break out between the cliff stone and the great marl stratum.

Cliff Limestone, 86 *feet thick.*

The cliff limestone at West Union, consists of 3 layers partially blended into each other. The first or upper part of the cliff is a rough, porous, soft limestone, filled with cavities which have been occupied by fossil animals, and which have decayed out. These cavities are lined with a dark colored bitumen. Lime for building and other purposes, at W. Union, had always been brought from a distance of several miles; and when I pronounced the rocks under their feet to be good lime, I was disputed. A small piece being put into a blacksmiths forge, heated and afterwards slaked on the anvil, fell into a fine, soft powder, with very convincing characters, especially if applied to the tongue. The second, or middle portion of this cliff limestone, is aluminous, and somewhat arenaceous, of a slaty structure, dark grey color, and comparatively hard. The third and bottom portion is more sandy. It is massive, light colored, rather free to work, and is quarried as a building stone. It has been opened at Darlinton's quarry, head of Beasly's fork, in a stratum 20 feet thick. Both this and the second or slaty layer effervesce but slightly with acids, and on solution in acid, leave a fine sediment or mud,

consisting of clay and fine sand, and there rises on the surface of the solution a film of bitumen. They contain about 60 per cent. of carbonate of lime, but do not slake perfectly after burning. If pulverized after calcination, and mixed with sand, they harden under water, and might be used for hydraulic cement. The upper layers of the cliff limestone are often extremely rough and ragged, having numerous holes and irregular cavities, corallines and peculiar nodules, composed of loose concentric layers, bearing a distant resemblance to decayed and half broken skulls.

The great Marl stratum, 106 *feet thick.*

This forms the immediate sharp descent of the various hills around West Union. When lying undisturbed it has the blue color common to clay, and is evidently stratified. When decomposed by the frost and weather, it becomes lighter colored, and when dried is almost white. It is earthy, highly effervescent, contains few fossils, and has thin layers of slaty limestone, 2 to 3 inches thick, traversing it at remote distances. These layers of limestone are of a reddish color and have, when broken, a feldspar-like gleam from a uniform crystallization. The upper surface has generally ridges like the roots of trees, or the trunks of small vegetables about a fourth to half an inch in diameter, variously ramified over it. These do not appear to be corrallines. They may be the trunks of marine plants. The under side of these thin layers is flat and smooth, and they would answer well the purpose of flagging stones.

The great marl deposit forms, according to circumstances, three different sorts of soil.

1st. When it forms a slope under the cliffs, as it does about West Union and numerous other places, the water from above flows over it, and it produces the sugar tree, and becomes covered with a rich mould suitable for wheat or corn. If it lies in a steep declivity, it is liable, after the trees are removed, to slip in large avalanches, blasting entirely the prospects of the husbandman. The inhabitants have learned to distinguish this kind of land without knowing the existence of a general stratum which produces it. They call it "cove land."

2d. When the natural level surface coincides with the great marl layer, as it does for some distance north of W. Union, on the road to Hillsborough, the soil is rather inferior, and produces a forest of white oak. Such plains are called "white oak flats."

3d. When it is left in conical mound-like outliers, the marl is often almost barren of trees, and produces some peculiar prarie like plants, as the prarie docks, wild sunflowers, scabish, rudbeckias, &c. These places are called "bald hills," and "buffalo beats." Several occur within a mile of West Union, in a northerly direction, and would be quite a paradise for the botanist.

The Flinty Limestone, fifty-one feet thick.

This stratum, like the blue limestone, lies in thin layers interstratified with marl, but it differs from the blue limestone in color, in fossils,

Green Burrh Stone.

This is a "calcareo-silicious rock," occurring in detached semi-nodular masses, immediately on the top of the flinty stratum, not general, but only locally presented. It is compact and flinty, of an agreeable apple green color, rough and cellular, often containing liquid bitumen, white crystals of carbonate of lime and some fossils. It is seen in the greatest perfection on the descent into Soldier's run, just above Grooms's mill. The largest piece which I saw, was about 2 feet wide, 5 feet long, and 6 inches thick. It has been fitted together in the same manner as the French burrh to form millstones, which are now in use, and are said to perform as well as the Raccoon burrh stone.

Inferior Marl Stratum, 25 feet thick.

This stratum is the common blue clay marl, and has nothing peculiar, except that at the lick it includes a thin slaty layer of bluish limestone, similar to that described in the great marl deposit, except that the stem-like bodies are on the *under side* of it, and two or three inches in diameter. I apprehend that this stratum of marl is not very uniform in its thickness, but is liable to be encroached upon by the stony layers.

The Blue Limestone of indefinite thickness.

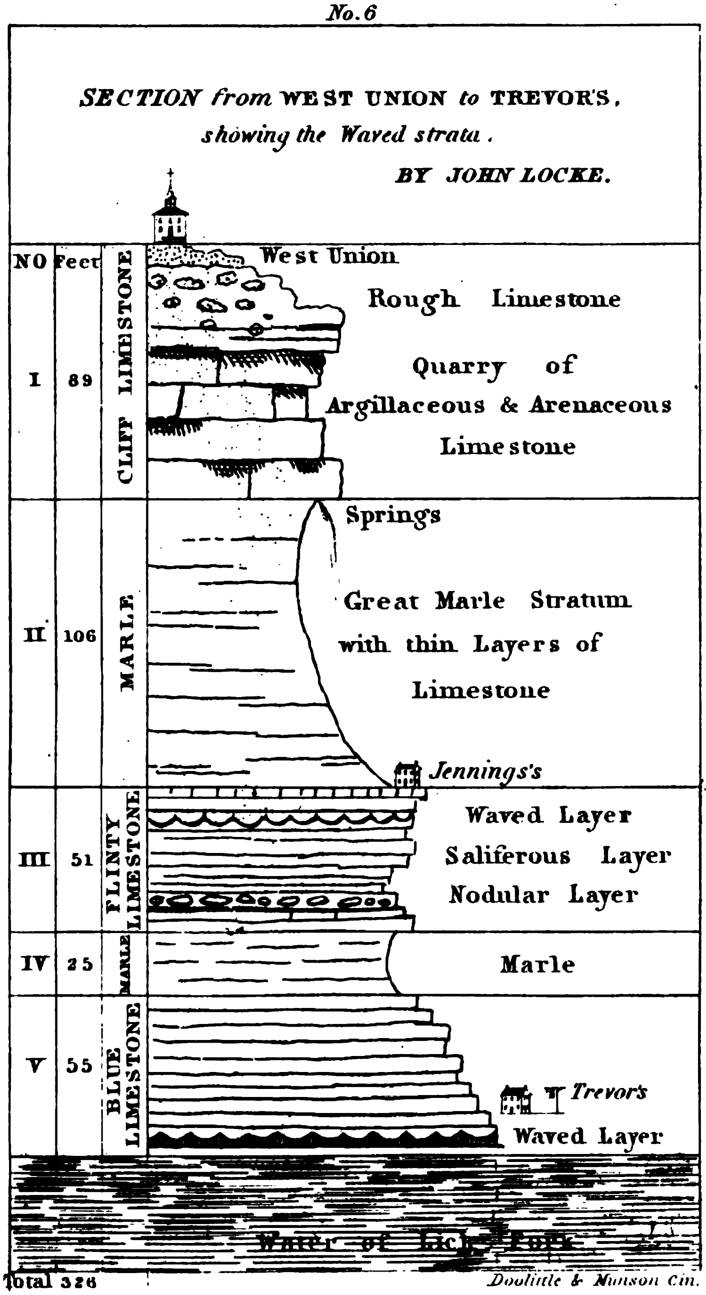
The proper blue limestone, with its characteristic fossils, commences in the bed of the fork, within a mile below Jennings's. I have elsewhere given its characters, but two peculiar subjects which occur in it below Treber's, and about 50 feet below the top of its stratification, claim our attention. These are a peculiar *waved stratum*, and a large species of trilobite.

The waved strata.

These occur in the cliff, in the flinty, and in the blue limestone. They are not simple bendings of a layer, but occur in the following form: The under side of the stratum is flat and straight, like that of any other layer, while the upper side is fluted out in long troughs 2 to 3 feet wide, and about 2 or 3 inches deep, the edge or ridge between them, being generally sharp, as in the section below:—[*See Plate No.* 6, *V.*]

These waves are not local, but may be traced in the same stratum over tracts of many miles. They have been called "ripple marks;" but all geologists will agree that the blue limestone has been formed far below the reach of "ripples." One circumstance would seem to throw some light on the subject. *There is always one stratum of clay marl immediately above, and another immediately below a waved layer of limestone.* Now, if you take soft tar, or any other semi-fluid, and lay ridges of sand along upon it, the weight of the sand will depress the tar immediately underneath each ridge, until the tops of those ridges

No. 6


SECTION from WEST UNION to TREVOR'S,
showing the Waved strata.
BY JOHN LOCKE.
NO
Feet
I
89
CLIFF LIMESTONE
West Union
Rough Limestone
Quarry of Argillaceous & Arenaceous Limestone
II
106
MARLE
Springs
Great Marle Stratum with thin Layers of Limestone
Jennings's
III
51
FLINTY LIMESTONE
Waved Layer
Saliferous Layer
Nodular Layer
IV
25
MARLE
Marle
V
55
BLUE LIMESTONE
Trevor's
Waved Layer
Total 326
Doolittle & Munson Cin.

will perhaps become flat, and the tar in section assume the form above exhibited. If a perfect liquid could have ridges of powder, a little lighter than itself laid upon it, those ridges would not be heaped up, but would sink down a little, while the liquid would rise between them until a surface nearly level were attained; the whole forming one stratum, with top and bottom parallel, but with the joining surfaces waved. This can actually be done with sawdust of heavy wood, and water. Now it is only necessary to suppose that, while the lime is fluid, the marl, which is a sedimentary matter, falls down *in sheets*, or vertical strata, as we sometimes see a shower through the air, in such a manner as ultimately to settle in ridges or long "winrows," to account for all of the phenomena. Such a mode of deposit would be likely to take place in deep tranquil water, where the marl, in descending, would create alternately downward and upward counter currents. The above may be called a speculation, but it can hardly be said that in this report, I have wandered far into theoretical disquisitions. The waved stratum at Treber's, is exposed in the bed of the fork, about 400 feet in length, and 50 feet in width, forming a feature sufficiently interesting to arrest the attention of every traveler, especially when the water of the stream was dancing transversely over the ridges.

Isotelus maximus, found near Treber's, in Adams county.

The Isotelus maximus is a species of Trilobite. This is not the place to go into a particular account of the extinct fossil family, called trilobites. I will just observe, for popular information, that they were not unlike the horse-shoe crab in their structure and habits. They are now found only in a state of petrification, and they mark rocks of a particular age or period in creation, called "transition limestone." Like the crab and lobster, they had a shell which is entire over the head, and in bands or separate plates over the rest of the body; or in some kinds the tail also is covered with one entire jointless crust or shell. This is the case in our specimen, which, with a kind of shovel shaped termination at both ends, was well calculated for making his way in the mud, either backwards or forwards. His large eyes, placed on the highest part of his body, enabled him to see in all directions around himself. Legs are not an ordinary appendage of the fossils. They may have existed; if so, they have perished. The animals were of various sizes, from less than an inch in length to 21 inches. "The trilobite is supposed by naturalists, to be one of the first animated beings of our earth, called into existence by the great author of nature." There is therefore no small degree of curiosity existing with regard to them, and we have made the above remarks chiefly to induce people to preserve them when discovered. They are popularly called "petrified locusts, petrified butterflies, petrified bugs, and petrified frogs."

At the waved stratum the blue limestone abounds with fossils. Orthoceritites and fragments of large trilobites are peculiarly abundant. These are rendered very beautiful from the fact that the shells of the fossils has often been replaced by pyrites, which exhibits them with a

beautiful surface of golden bronzing. I had broken a large specimen of blue limestone into small pieces in search of fragments of trilobites, when I discovered in one of them the lines or broken ends of one of uncommon size. In order to recover the whole of it, I was obliged to set about the puzzle of putting the fragments of the stone together. After several hours of industrious labor in a hot sun, with the thermometer in the shade at 86°, I succeeded and obtained the fragment which is represented in print No. 8. The engraving is a little less than the natural size, being seven-eights of it. The fragment found was only, as represented by that curved central part of the drawing, marked with veins, which in the specimen was five inches long, and one and three-eighths broad. The rest is only a sketch roughly modelled to give the symetry, or to complete to the eye the left hand half. It is a fragment of the under margin of the tail or post abdomen of the animal, and when viewed side ways, exhibits a convex and a concave part precisely like the "moulding" called the "O-gee." This is exhibited by the line A. B. below the drawing, where C. D represents the probable situation of the outer crust or shell of the animal. This lower figure represents the probable section of the post abdomen of the animal in the line of A. B. on the first figure. I afterwards found the whole of the exterior shell of the posterior part of an animal of the same species, but of a smaller size, little more than one half of the dimensions of the first specimen, in which, by a fortunate fracture the lower or interior margin of the animal, as seen in the first specimen, was exposed. For a figure of this specimen, see the lower third of the drawing No. 9.

Drawing No. 9. This is intended to represent the animal of which the above named specimens are fragments, restored in the proportions of the Isotelus megalops of Green. I will now proceed to give an account of the authority which I have for the figure of the Isotelus, for which I propose the name of *maximus*, it being so far as I know, the largest specimen of the trilobite family known. The *size* is derived from the fragment No. 8. Two tangents being drawn to the extremities of the exterior curvature, and a cord drawn from the contacts of those tangents, the perpendicular was let fall from the middle of that cord to the vertex of the curve. The cord and perpendicular were then both measured. The same tangents, including the same angle was next applied to the smaller specimen, and a similar cord and perpendicular drawn. These were found by measurement to have the same proportions as the similar lines in the former specimens, and to be each a little more than half as large. A drawing was next made of the smaller specimen enlarged to correspond to the larger fragment, which drawing is seen in the posterior third part of fig. 9. As this post abdomen corresponds very nearly to that of the Isotelus megalops as shown in cast No. 25, accompanying Dr. Green's monograph, I restored the animal in the proportions of that specimen as shown in figure 9. I have unquestionable authority that the post abdomen of my specimen was 7 inches long, and this in the genus Isotelus is very uniformly one-third of the length of the entire animal, giving the entire length 21 inches.

I am not quite sure that my specimen is not actually an overgrown megalops of Green; the character "cauda suborbiculari limbo lato," applies exactly, and the only definable difference which I can perceive between Dr. Green's specimen and my own is, that the length of the post abdomen in his specimen is two thirds of its width, while in mine *it is less than two thirds.* The size, which is hardly a charater, is very different, his being 5 inches, and mine 21 in length. I merely propose it as a new species, under the name of maximus, leaving it for those who have the means of more extensive comparisons than I possess, to determine the question.

I have casts of my specimens which I should be pleased to forward to naturalists desirous of examining them.

Bald hill and Cave hill.

To the north and west of West Union are several similar outliers of the cliff limestone quite elevated above the surrounding country and commanding extensive prospects. Their geological position is the same as at West Union, their tops being at the top of the cliff limestone. In altitude, as they are in a direction opposite to the dip, they are higher than West Union—Bald hill near 50 feet, and Cave hill near 100. Bald hill is qute an insulated elevation and would be an excellent observatory in a trigonometrical survey of the county. Bearings* taken at Bald hill:

Distant knob	118½°
West Union with high knobs on each side about 1 deg. distant,	128½
Knob	131
Knob	133½

A pleasant farm and a fine spring are found on the top of Bald hill, but the marl at the south side is "*bald*," whence the name.

Cave hill is a mile or two northwardly or northwestwardly from Bald hill, and has a broader terrace, but a narrower pospect. James Gibbon has a good farm upon it, and to be near the fine spring, which flows out at its geological place, the top of the great marl deposit, has placed his house on the lower declivity of the cliff limestone some distance from the road. Near the road is the *cave* which is entered by descending into a conical crater or "sink hole." There are several of these sink holes in the neighborhood, which indicate that the rock is cavernous to some extent. I had no light and did not explore the cavern further than to proceed beyond the light of the entrance in order to take the temperature, which I found to be 54 degrees, the external air being 90. Mr. Gibbon's spring had the same temperature as the cave.

Barometer at Gibbon's spring, August 10	7401
" " " house	7393
" " the cave, outside	7386
" " the top of Cave hill	7371

* These bearings are reckoned from north, eastwardly, quite round the circle.

Heights above the spring.

Spring	00.0 ft.
House	27.6
Cave	51.7
Hill top	103.5

The Brush creek Forge and Split-rock hill.

The forge is about five miles a little south of east from West Union, on the west side of Brush creek, from which it receives water by a dam above, to drive its machinery. It is at present an appendage to the Brush creek furnace, being used to manufacture the pig iron from that furnace, into wrought iron blooms. In the greatest number of cases the people seemed entirely ignorant of the nature and object of the geological survey. Many of them had never heard of it, and viewed me as a man deranged, or some kind of a wizzard speculator, my barometer being a divining rod, with which I extracted "goold" from their soil. Not so with men possessing the intelligence of Mr. Fisher, the proprietor of the forge, and a partner in the furnace company. By observation this gentleman had become a practical geologist with reference to all of the useful materials in his neighborhood. I felt very much at home while enjoying his hospitality and conversation. At the forge, Brush creek bears close against the hills on the east side and leaves a bottom or intervale on the west. This bottom was overflowed in the great flood of 1832 by the back water of the Ohio, which came into Mr. Fisher's house. This fact enabled me to fix a point of altitude from which to start my barometric levelings. I assumed the height at Mr. Fisher's dwelling to be 82 feet above low water at Cincinnati.

Ascent of Split rock hill, near the forge.

This ascent was made in company with Mr. Fisher, and the section was found to be almost identical with that at West Union, with the exception that the little marl deposit seemed to be encroached upon by stone, and the slate caps the top of the hill as an outlier. The following are the heights of the several points as indicated by the barometer:

Mr. Fisher's house above low water at Cincinnati	82 feet.
Top of the blue limestone	100
Top of the flinty limestone, at Hazelet's	189
Bottom of the cliff limestone at Hazelet's	325
Top of cliff	465
Top of the hill	524

The great marl deposite which seems here to be thickened to 136 feet, presents a broad slope of "cove land" on the hill side, covered with a fine growth of sugar-tree. On this slope, Mr. Hazelet has made a

farm which has lately been nearly ruined by slides. The whole surface has moved and thrown itself into fissures and ridges. The cliff limestone, as usual, presents a quarry stone in its lower stratum, but is rough and fossiliferous in its middle and upper layers. A narrow spur of the cliff about three-fourths of a mile south-east of the forge forms an insulated and almost inaccessible rock, which is quite a curiosity. It is 53 feet high, presenting a level terrace on the top, 92 by 36 feet. The upper part of it is a tolerably pure limestone, the lower part is a loose arenaceous limestone filled with large corallines, and disintegrating by asmospheric agency, has been reduced to 10 to 20 feet in width, leaving the upper portion standing like a head on a small neck. Three sides of this are over-hanging and inaccessible. At the fourth side it has been split from the contiguous hill and the clift has opened about two feet, from which circumstance I ventured to give it the name of Split-rock. I made a sketch of it as seen from below, and Mr. Cleveland has drawn it upon stone, as seen in fig. 10. It is remarkable that although thus insulated and scarcely covered with soil, the flat top of Split-rock bears a great number of herbs and small trees. I made a catalogue of such as I saw there. Red oak, black oak, chesnut oak, cedar, pine, ash, sycamore! water maple! box-elder, red bud, butternut, hazle, hornbean, hydrangea sumack, 3 leaved sumack, June berry, mullein, balm, (monarda), sandwort, yellow flax, sassafras, grass 4 species, saxifrage, white plantain, columbine, eupatorium, ferns 4 species, houndstongue, strawberry, blackberry, raspberry, huckleberry, cinquefoil, thistle, garlick. Many more might be found by watching them through their season. It is evident that the rock itself is concave on the top, and includes within it a reservoir of water to which the roots of the plants descend. Immediately above Split-rock, and beyond the cliff, commences a gradual swell of soil formed by the disintegration of slate, and producing cedars, pines and chesnut oak, which last tree, in this neighborhood, furnishes the tanner's bark.

Bearings from split rock.

Mr. Fisher's house	348° or N. 12° W.
Greenbriar hill	114½° or S. 65½ E.

Greenbrier is about 2 miles distant from Split-rock, and is seen from West Union.

Bearings from the top of Split-rock hill.

Steam furnace knob	N. 16½° E.
Fort hill	N. 11° E.
Gap and knob in Highland county	N. 6° & 7½° E.

The above are the magnetical, not the true bearings.

The Iron Ores of Adams county.

The Brush creek iron ores lie in basins of limited extent, and irregular form, in the cliff limestone, apparently in its upper portion. The ore seemes originally to have been pyrites in huge nodules, and collec-

tions of nodules in the rock. Where these became uncovered and exposed to the influence of water, and the lime which is more or less intermingled, a decomposition ensued, the sulpher was abstracted and the hydrated peroxide of iron remained. Wherever the ore is covered by stone, and the agency of the weather excluded, it is still nodular pyrites somewhat decomposed. In one instance a drift was made into an ore bed, under the rock at Brush creek furnace, and plenty of heavy, beautiful gold-like ore procured, "but so full of sulpher that it could not be worked." The fact of the decomposition of the pyrites by lime, was made evident by the occurrence of sulphate of lime surrounded by oxide of iron.

Brush Creek Furnace.

Mr. Fsher, who had entertained me very hospitably at the forge, accompanied me to the furnace, where I received every attention necessary for my comfort, from Mr. Stuart and family.

The furnace stands on the south side of survey 2615, and close upon the stream of Cedar creek, the waters of which drive its machinery. Geologically, the furnace stands near the top of the flinty limestone, and has the "cove land" of the marl slope, on each side of the creek, between it and the cliff limestone, which, in bold and overhanging escarpments, overgrown with cedars, terminates the view. It was erected in 1811, by Paul and McNickel, of Pittsburg. The ore was thought to be nearly or quite exhausted—the furnace finally abandoned and sold to the present proprietors, Messrs. Stuart and company, who, in the present year, have opened a new bed of ore, and with 12 hands, during 119 days, made a blast which produced 200 tons of pig iron. Mr. Stuart's house is 56 feet above the bed of Cedar creek. Cedar creek is about one hundred and sixty-five feet above low water at Cincinnati. The bottom of the cliff, 91 feet. Top of the cliff, 151 feet. 15 ft. below this is the ore bed. The soil above the ore is red, like burnt ochre. This appearance is very common in Adams county, without any workable ore below it. The ore itself is in cellular nodules, being in thin plates or laminae, forming the partitions of the cells. The cells themselves are often filled with a bright fine plastic yellow ochre. The cliff limestone, in this vicinity, is exceedingly rough and sandy, abounding with cyathophylla and large corallines. In the ore bed, it seems to be disintegrated, lying in detached nodular masses mixed with loose calcareous and silicious sand, The ore at the steam furnace is exhausted, yet it is kept in blast by ore brought from a distance. Marble furnace is deserted; yet Mr. Sommers, the present proprietor, has a delightful farm at the locality.

Ascent of Furnace hill, from the Brush creek Furnace.

In company with Mr. Fisher and Mr. Stuart we ascended to the southeast, and presently came to the slate or shale formation. The rock does not crop out, but exfoliated masses of slate appear in the soil in scales

1 to 2 inches in diameter and perhaps an eigth of an inch thick. Undershrubs become abundant. I was strongly reminded of the origin of the name of the contiguous stream. The huckleberry bushes with ripe fruit abounded in the open places. Among other trees, the chestnut begins to show itself, which is, I believe, scarcely seen to grow in the limestone region. After ascending several sharp acclivities, one of 30 deg. and another of 35, we came to the fine-grained sandstone, where it had been quarried for furnace hearth stones, in a stratum 3 feet thick. This point is 707 feet above low water at Cincinnati. Barometer, 736.4 millimeters; thermometer, 16 centigrade. Ascending still further, we came to the top of the hill, where the barometer stood at 733.8 millimeters= 28.596 inches, and thermometer at 16, centigrade=61 degrees F., a cool place for 10 A. M., July 12. This would give a height above low water at Cincinnati of 797 feet. The top of this hill is a level terrace of some acres having a deep rich soil, and producing a heavy growth of timber. It divides the waters between Cedar creek and South fork of Scioto Brush creek. Since examining my notes, I have come to the conclusion that this was near the top of the sandstone stratum. On descending, we saw abundance of game. Squirrels, rabbits, and wild turkies presented themselves, and I was told that deer were also not uncommon. Indeed this could not be otherwise in a country so thinly inhabited as the eastern part of Adams county, with abundance of mast for food, and dense forest for shelter.

Some observations on the northeastern part of Adams county.

From Sample's tavern at the "crossings" of Brush creek, 9 miles from West Union, the ascent to Jacksonville presents a section almost identical with that at West Union.

From the water to the bottom of the flint limestone, is		58 ft.
Flint limestone	51 ft.	109
Top of marl	96	205
Jacksonville	76	281

The bed of Brush creek is then about 25 to 30 feet in the blue limestone, and Jacksonville near the top of the cliff limestone. The surface of the country from Brush creek furnace to the steam furnace, and from Jacksonville to Locustgrove lies on the cliff limestone, is nearly level, with a thin soil, often ash colored or almost white, producing naturally white oaks. With good management it produces wheat, but some of it, even where it is settled, needs more nursing than it is likely to receive. The cliff stone in these places is more porous and arenaceous than elsewhere, and at Locustgrove, it has disintegrated into a kind of sand and gravel through which a plough may sometimes be driven. From Jacksonville to Locustgrove, the stone, in its out-croppings, exhibits numerous nodules of spary crystals which the treasure hunters have christened "silver blossom," and have wasted valuable time in useless and absurd explorations.

These spary nodules sometimes graduate or blend into a black substance, which gives opacity, and the spar adds lustre till there is an appearance quite like Galena or lead ore. This has served still further to excite the imagination of dreamers. This black substance should be analyzed.

Examination in the vicinity of the Steam Furnace.

The stream on which the furnace stands is small, but yet has cut a channel deep in the rocks; and, falling rapidly below the furnace, presents, within one fourth of a mile, perpendicular cliffs 70 to a hunhred feet high. At the point where it has cut quite through the cliff, and makes its bed in the great marl stratum, the channel opens on the left into a slope of 30 degrees, while the cliff is perpendicular or even overhanging on the opposite side. The slope on the left is formed by the surface of the marl, which having no other solid materials than the thin slaty limestone which traverses it remotely, will not lie steeper than 30 degrees, or an elevation of 5 feet in 10. The continued rains of a wet season had so softened the soil on this slope, which does not permit the water to sink away, that with all of its load of trees, rocks and springs, it had slidden into the stream below, leaving the grooved blue clay marl bald for 100 feet in length up and down the slope, and 2 or 3 hundred in breadth.

As this marl stratum extends, I believe, over the whole of the eastern and middle parts of the county, it presents, in the valleys of the streams, peculiar slopes commencing immediately under the cliffs, where they abound with copious cool springs. (Temperature, 53 to 54°.) Having a large portion of lime in its composition, it communicates great fertility to the soil. It has already been noticed that such lands are called "cove lands." If this marl were dug out and applied to the poor soil on the terrace of the cliff rock, it would undoubtedly fertilize it. The bluff opposite to this avalanch, is a picturesque object, and its outline near the top resembles the profile of a Turk, and received the name of th Turk's head.

The rocks through this ravine, were all feebly effervescent. The lower portion, about 20 feet thick, is a tolerable quarry stone, and works like a sandstone. The middle portion, 15 or 20 feet, is slaty in structure, but still contains lime. The remainder, 60 or 70 feet, is a ragged nodular rock, including the ore beds.

Ascent from the Steam Furnace to Grassy hill, 1½ mile east of the Furnace.

As might be anticipated, the land in the neighborhood of an iron furnace is soon stripped of its timber, and a naked mooreland dreariness prevails. Wood roads, copsewood, and "coalings" are the features of the scenery. We made our approach to the hill through an old woodroad, and at first passed over the common oak terrace of the cliffstone. As we advanced and gradually ascended, we came to the huckle-berry bushes and the chestnut trees, the signs of the slate region, and finally

leaving the beaten path we entered the "tangled thicket" to ascend the sides of the terminal cone of the knob, where we learned practically the origin of the name *Brush* creek; for the brush was not merely close set, but numerous grape vines passing horizontally from one young chestnut shoot to another, disputed every rod of our pass. On the slope sides of the hill, was abundance of a broad leaved, cutting grass, (andropogon,) and a fern, (osmunda,) both indicative of a wet soil. We finally arrived at the top, which is a terrace one or two hundred feet wide and a thousand feet long, nearly destitute of trees, but covered with grass and copsewood. We took our station on the southeast brow, from which several bearings were taken:

Jacksonville, W. 1½° S.	268½°
Steam furnace, the same, W. 1½° S.	268½
West Union, W. 47½° S.	222½

Four other knobs, not more than one and two miles distant, had the following bearings:

First	206°
Second	197½
Third	177
Fourth	167
A distant precipitous knob, (Greenbriar?)	195¼

Knobs to the northward, about Sinking spring.

First	342½°
Second	344
Third	345
Fourth	346½

Knobs to the right of W. Union.

First	236¾°
Second	238½
Third	241½
Fourth	243½

From this last a high ridge extends five or six degrees further to the west.

Barometer, July 14, 12 A. M., 739.4 millimetres; temp. 26.5, centigrade.

The height of Grassy hill, obtained barometrically, was 735 feet above low water at Cincinnati. The top of Grassy hill is within the region of the fine sandstone, but that rock does not appear in place or in regular layers. Fragments of it are abundant, some of them bright red, and so much rolled down the slopes that I was unable to determine where the slate commences.

Valley of Scioto Brush creek.

On looking over the map of Ohio, it will be seen that the eastern part of Adams county, the contiguous parts of Scioto and Pike, are to a great extent destitute of towns, roads and other marks of settlements, except in narrow valleys along the borders of streams. This region is a sort of desert, consisting of broken and precipitous knobs of slate and sandstone, often covered on the slopes with a *talus* of loose fragments of the latter rock. Through this region I passed by descending the north fork of Scioto Brush creek, ascending the south fork of the same, and descending the lower Twin, to Rockville.

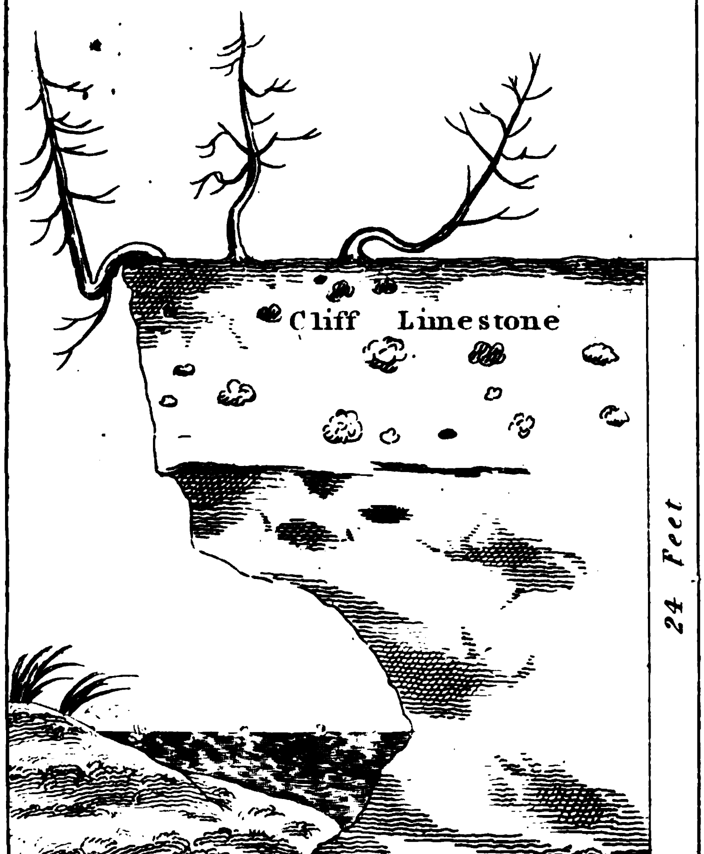
At Locust Grove, where our journey commenced, I received much valuable information from Mr. Cannon of that place.

Ascending from the waters of Crooked creek, at Locust Grove, we reached the summit, between it and the waters of Scioto Brush creek, within half a mile. Here a barometrical height was taken. From this point, the knobs or slate hills, capped with fine sandstone, are seen eastwardly, ranging north and south to an indefinite distance. Our first view of Scioto Brush creek, showed it in a deep channel in the cliff rock, surmounted with cedars. So firm and thick is that stone in this place, that it sustains itself in over-hanging masses, projecting over the water in some places 20 feet. The upper part of the rock merely overhangs, leaning rather beyond a perpendicular, while the lower part has been undermined or cut away by the stream, which almost conceals itself under the cavernous base. As we came upon these waters, sheltered thus from the scorching sun in a hot day, several boys were enjoying the luxury of a cool bath in one of the lagoons of the stream. This fact, not precisely geological, in itself, showed that the soil in the neighborhood was habitable, and productive in young shoots of the human species. Plate No. 13, shows a section of the channel and contiguous cliff,

A barometrical observation was taken at this place. (See appendix.)

As we proceeded down the creek our road was often very rugged, lying over the rude slopes of the naked cliffs, as we descended and ascended across the channels of the small rivulets. On these slopes the stone had often the form of stairs, with occasionally a perpendicular rise of 20 inches. At the distance of about 6 miles from Locust Grove we arrived at Mr. Smalley's, to whom we had been directed for information relative to the sulphur licks which occur in that neighborhood. Here the cliff limestone, over which we had been traveling, is covered by a slate hill, and sinking still deeper and deeper as it proceeds on the line of the dip, disappears altogether beneath the surface at a short distance to the eastward. Even above or west of Mr. Smalley's, on the north side of the creek, the slate shows itself in a bald perpendicular side or mural escarpment of a knob. It is at this junction of the slate and limestone, that the sulphurious and chalybeate springs make their appearance. At Mr. Smalley's, and just above the level of the contiguous stream, and a few feet below the top of the limestone, is a spring discharging about 50 gallons of water per minute

No. 13



SECTION of the Channel of Scioto Brush Creek 4 Miles E. of Locust Grove

BY JOHN LOCKE.

Doolittle & Munson Cin.

at the temperature of 54 degrees, and giving the name to the neighborhood, of the "Big Spring." In about 10 feet above the spring commences the slate and rises into a mountain, capped with sandstone, fragments of which have rolled to the base. The slate or shale formation commences with about 10 or 12 feet of clay, which separates the slate proper from the limestone beneath. Along the base of this hill, and at the margin of the fork, the sulphur springs appear for perhaps a quarter of a mile. The quantity of water is small, but highly impregnated with "sulphur," (sulphuretted hydrogen,) having the fœted smell, the nauseous taste, the black mud, and, as it runs off, the milky precipitate which characterize such springs generally. That they contain saline matter is evident from their having been the resort of buffaloes, elks, deer, &c., before the country was settled, and from their strong attractions for domestic animals at the present time. Hogs, cattle and horses were wading in the black mud, as if they were swimming in voluptuousness. Mr. Smalley informed me that cattle accustomed to the springs could scarcely be sold or retained at a distance from them. They had been known to return from a distance of 20 miles to revisit them. On the opposite side of the stream, and in a shallow depression of perhaps an acre, wild animals used to congregate and lick the soil, keeping it constantly bald of vegetation. Indeed the immediate depression of 3 or 4 feet, which takes place rather abruptly, is supposed to have been literally eaten out by herds of wild animals operating upon it for ages.

There seems to be no spring or source of salt within this shallow crater; and I came to the conclusion that its clayey impervious bed was a receptacle during wet weather for the saline lixivium of the surrounding springs where it afterwards became concentrated by spontaneous evaporation. With this view of the subject, I ventured to discourage any digging for brine below. Viewing the springs as an emanation from the slate which lies above them, I ventured to discourage the experiment of boring which had been proposed by the proprietors. I have lost the memorandum of my barometrical observation at Smalley's springs. The height is, however, about 250 feet above the level of low water at Cincinnati.

On descending the creek below Mr. Smalley's, the soil is that formed from the slate, and becomes deeper and better adapted for Indian corn, (maize,) and grass, than that lying on the limestone which is rather a wheat soil. The road becomes smooth and the mud less saponaceous and adhesive than in the lime regions. On the bottoms and little terraces of the hills where soil can accumulate, it is a light black alluvion and bears the sugar tree and the black walnut.

At Mr. Thomas Thompson's, a fraction of a mile east of Adams county, and within the limits of Scioto, we took lodgings. Here, as the sandstone, in consequence of dip, is coming lower and lower on the hill caps, the road begins to be impeded by numerous fragments of it, which have been detached from their place and rolled over the slate to the bottoms of the hills, along which the road runs. The streams also bring down great masses which from the soft nature of the rock,

get quite rounded in this short distance, taking the appearance of large water-worn pieces of granite. The bottoms or alluvions are very fertile and afford good farms. As this is within the Military District, the locations of lands has been made to suit the taste of the purchasers. These narrow strips have been taken up, while the barren hills are still the property of the government; affording, however, a fine range for the cattle and hogs of the scattered inhabitants, and no small quantity of lumber, such as staves, hoop-poles and tanner's bark, which are unscrupulously taken from the public lands. Indeed, there is a vagrant class who are supported by this kind of business. They erect a cabin towards the head of some ravine, collect the chestnut oak bark from the neighboring hill tops, drag it on sleds to points accessible by waggons, where they sell it for perhaps two dollars per cord to the waggoners. The last sells it at the river to the flat-boat shipper at six dollars per cord, and he again to the consumer at Cincinnati for eleven dollars. Besides this common trespass, the squatter helps himself out by hunting deer and coons, and 'tis said occasionaly by taking a sheep or a hog, the loss of which may very reasonably be charged to the wolves. The poor families of the bark cutters often exhibit the very picture of improvidence. There begins to be a fear among the inhabitants that speculators may be tempted to purchase up these waste lands and deprive them of their present advantage of 'range' and lumber. The speculator must still be a non-resident and could hardly protect his purchase. The inhabitants have a hard rough region to deal with and need all of the advantages which their mountain tract can afford.

On leaving Mr. Thompson's, we were obliged to advance perhaps 3 miles further into Scioto connty, in order to reach the "south fork," which we proposed to ascend to the heights and descend on the other side to the Ohio river. For a mile or two, Mr. Thompson accompanied us and showed us on the road a chalybeate spring, which deposits a tufaceous iron ore. About 2 miles below Mr. Thompson's, seeing the sandstone crop out on the hill side, we ascended the knob to the top of it. The following are the barometrical observations:

August 13, 6 A. M. at Mr. Thompson's—barometer 751.6; temperature 16° centigrade.

9 A. M. at surface of the creek	754.0;	temp. 27°
At the top of the slate	750.5	" "
10 A. M. at the bottom of sandstone	749.7	" "
At top of the hill	742.0	" "

It appears from these observations that the hill was 414 feet above the water of the creek. To this add 203, the approximate hight of the water above low water of Ohio, and we have the whole height of the knob, 617 feet.

I met with several personal incidents in which even life was endangered, but I have studiously avoided a narrative of them in this report. As the following disabled me somewhat for a time from the usual very active mode of prosecuting my pursuits, I venture to present it.

In preparing to ascend we had driven the wagon qute out of the road and tied the horse securely to a tree. On descending we found the horse had been untied and led into the road, while a long-nosed, lank-sided species of hog common to this region, was a little ahead with a sheaf of oats in his mouth. It appeared as if the plan had been laid by some "native" to have the hog with his oats entice the horse, and the horse pursue and impel the hog. This exhibited a grade of wit certainly not very high in the scale, but yet quite as high as a large proportion of that which seems to be very self-satisfying to its author. The horse being too well disciplined in his duty of eighth geological assistant to be guilty of any such insubordination, kept his ground. We seated ourselves and proceding a few rods, met a man with a load of oats who seemed not inclined to give an inch of a road which was only 6 feet wide, but beckoned to us to turn out upon the side hill. Having been in a habit of driving over almost every thing, I thought I could safely do it. But being heavily laden with boxes of specimens, and, having my little son in the wagon with me, I was unable to keep its balance, and in turning again into the road it upset. Having my barometer slung to my back, and taking care of it and my son I received the shock upon my hip bent laterally, which, although the bones were neither broken nor dislocated, was so much injured as to give acute pain, and disable me from walking. The climbing of hills to take their altitudes was therefore interrupted for sometime. Fortunately neither my son nor my engineering assistant, the barometer, had received the least injury. It is probable that I had been taken for some speculator looking out for some of the precious land of those knobs. This idea is not quite so absurd as it might seem, for the tops of them have often a flat terrace of from 15 to 50 acres of excellent soil lying however 6 to 7 hundred feet high and destitute of water. How would the knobs answer for the raising of sheep?

After leaving the limestone at Big Spring, 9 miles above the junction of the West with the South forks, Scioto Brush creek changes its character, becomes more sluggish, and forms long, deep lagoons, filled with lilly pads, Nymphea, odorata, and Nupharlutea, the former of which, so far as I have observed, does not thrive well in limestone or hard water. Large masses of dead leaves are occasionally found almost obstructing the stream, or driven, with the drift wood, upon the slope of the bank. That the inhabitants should occasionally suffer, as they actually do, from fever and ague, is not surprising. Between those lagoons the stream falls over a bar of sandstone gravel, blackened with sulphate of iron derived from the slate, and the astringent matter from the oak leaves. The same characters occur on the South fork, for 10 or 12 miles. About 4 miles above the junction, and on the South fork, which we *ascended*, a slate bank presents itself at the side of the stream, which bears against it. We waded across to examine it. The bed, or bottom of the stream, is of slate, nearly level, and covered by water about a foot deep. The bank itself presents a face of slate 40 or 50 feet high, so steep as to be utterly inaccessible, disintegrating and falling into the stream in masses of small plates. Above this point we found the broken sandstone to be mostly absent, and the road to be vastly improved again; some of the

bottoms are broad and afford a heavy growth of beech, sugar tree, and poplar. On one of these bottoms is a beech marked for the line between Adams and Scioto counties. It is hacked almost "to death" from the bottom 10 or 12 feet upward. The tree, originally a large and fine one, had evidently become an object of persecution by every rough handed axeman who passes; for recent scores are numerous. It is truly a republican tree, first made to bear a public badge, and then endure the marks of public malignity. Wild and secluded as this region is, many of the farms afford to industry its proper reward of comfort and competency. In the absence of saw mills, some of the hewed log barns are in very superior style for that species of architecture, being 40 feet long, 30 wide, and 20 high, built with permanence and even neatness. Some neat brick dwellings have been erected. Mr. John Wycuff's farm is quite a desirable one. It is only those who waste their time in coon and deer hunting, and fishing for minnows, who are in abject distress. The settled inhabitants appear to be temperate, religious, industrious, grave, civil, and hospitable; and I felt happy in being separated entirely from grog-shops, cigar smoking, and "black-legs." Having travelled 16 miles I took lodgings at the house of one of the pioneers of Ohio, Mr. John Williams. His place is 13 miles from W. Union, and 12 from the Ohio river.

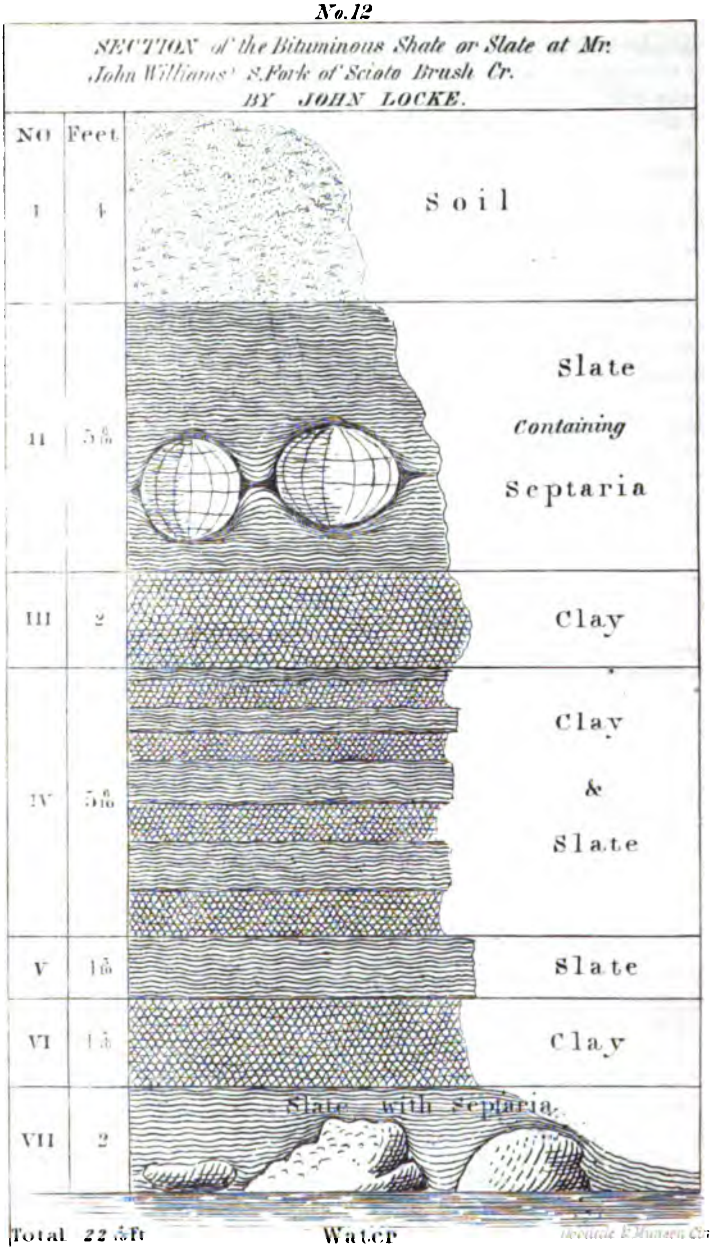
Slate at John Williams's.

The slate or shale stratum, 251 feet thick, has been well described by Professor Briggs in his report of last year. In its place it appears to be a massive rock of considerable solidity, often standing in cliffs nearly or quite perpendicular, for 70 or 100 feet in height. It is separable into very even thin laminæ, and appears as if it would answer for roofing; unfortunately it disintegrates on exposure to the weather, and falls into small pieces. It is very bituminous, and when heated will burn with a bright white flame. Sometimes the slate banks themselves have become accidentally ignited, and have burned for several days, but in general it will not support its own combustion. There seems to be no workable coal in the slate stratum. It contains sulphuret of iron, both in brassy or silvery nodules, and intimately and imperceptibly blended with the slate itself. This sulphuret decomposing, forms copperas and allum, which effloresce in the clefts of the rock, and, by solution, form chalybeate waters. The slate includes also septaria ludus helmontii, or large rounded masses of impure blue limestone, often a little flattened and cleft, the interior being filled with spary crystals of carbonate of lime, or sulphate of baryta. Although the slate bank of Scioto Brush creek, at Mr. Williams', is only a few feet in height, it shows all of the above characters strikingly marked. The accompanying plate, No. 12, is a section:

The strata of clay are slightly indurated and cracked by vertical and oblique seams; hence it is represented in the section by hatchelled or crossed lines.

The strata at this place have a local dip or undulation. On a line

No. 12



SECTION of the Bituminous Shale or Slate at Mr. John Williams' S. Fork of Sciota Brush Cr.
BY JOHN LOCKE.
NO
Feet
I
4
Soil
II
5 6/10
Slate
Containing
Septaria
III
2
Clay
IV
5 6/10
Clay
&
Slate
V
Slate
VI
Clay
VII
2
Slate with septaria.
Total 22
Water

bearing N. 60° E. 580 feet, the dip is 6½, and on another bearing N. 37° 150 feet, the dip is 2½ feet.

About one-fourth of a mile below Mr. William's, the nodules or septaria of limestone assume the form of globes either perfect or a little flattened, and are singularly marked with parallels and meridians, like the lines of latitude and longitude on an "artificial globe;" one 3 feet in diameter lies at the water's edge broken into two hemispheres; another, 9 feet in circumference, lies in situ, half raised above water in the middle of the stream, with its axis nearly perpendicular. The raised hemisphere and its reflection in the water, make, in appearance, a perfect globe, as really exists. The equatorial part of this globe is a little raised, forming a kind of ring like that of Saturn. Two others are in the perpendicular bank, 20 feet above the water, one of which is not a perfect globe, but a double conoid. I made a sketch of this extraordinary scene, which Mr. Cleveland has drawn very faithfully on stone. See the annexed plate No. 11. The meridians are marked by fissures, as if by a shrinking and splitting of the globe, exactly as would happen if they were turned in a lathe out of green wood, and suffered to shrink, the outside more rapidly than the inside, and consequently to split. These fissures are filled with crystalline spar. The parallels are the impressions of the slaty strata or planes, and often leave the equator somewhat raised at the parting of those strata, as shown in section No. 12, which is placed before No. 11. The position of the globe is of course with its axis, perpendicular to these strata. So singular a production could not fail to excite some speculation as to the mode of its formation. The oblate spheroidal figure of some of these bodies always flattened on the top and the bottom, shows that the substance of the globe was somewhat soft and yielding at the time of the deposite or final setting of the slate, the layers of which are not interrupted by the globes but are bent or wrapped around them like blankets laid over them. The fissures have evidently been formed, not by desiccation and unequal shrinking, but by compression from above and below, swelling the central axis or cylinder, producing the same relative effect; just as a ball of clay dried so as to loose a little its plaisticity, being laid on the table and pressed on the top by the fingers, would flatten and split open along down the sides. The parallel markings or rings which run round the globes are not fissures but obscure ridges, entering between the layers of slate, the equitorial or middle one being the larger, and entering between the junction of the inferior and superior strata of slate, where they wrap around and meet each other. The whole of this delineation requiring, apparently, the skill of the geometer becomes a very natural result of simple causes. I am aware that this extraordinary scene will probable excite the remark of such as can understand a subject better than those who have seen it, and are unwilling to admit any thing as true except that which has come under their own limited observation. Such persons will please to observe that I do not write romance for a geological report, nor give "fancy sketches" for true

sections of geological strata. The ludus helmontii have always been a curious subject to geologists.

Having finished my observations at Mr. Williams's, I struck off for a passage over the mountain, following a blind track, which is little more than a drag for bark from the heights. We turned off immediately to the left, leaving to the right our road to West Union, and another to Rome, within a mile. We passed Wait's steam mill, and proceeding S. 30° E. followed up the stream, our road lying indeed in its very bed, which is composed of rounded fragments of sandstone of all sizes up to 2 feet, and of indefinite depth, of course no water shows itself in such a bed, except in time of floods. As we approached the immediate ascent of the mountain we found sweet gum tree, the Liquidamber styracifolia, which is abundant. In about 4 miles we came to the top of the slate, where commences the immediate steep ascent up the cliffs of sandstone. Here the barometer stood, Aug. 14, 12 A. M., at 7482, temp. 26½° C. At Mr. Williams's, at 6 A. M., it had been at 7533, 18° C. In the meantime the basal barometer had fallen 9 millimetres. The cliff then would be 4.2 millimetres, corresponding to an approximate height of 145 feet.

Our ascent to the top was arduous, but quite as moderate as I had anticipated. The trees had been very much thinned at the top of the mountain, which is a narrow ridge or terrace of perhaps one-third of a mile, destitute of stone at the surface, and covered with bushes and grape vines. A large species of andromeda was still in flower, and a tall species of huckleberry or blue berry, which I had never before seen, was just ripening its fruit. Some scattered hickories and oaks of the forest still remain. A small oak tree on the side of the pathway marks the boundary line between the townships of Green and Jefferson. I am inclined to believe the stoneless stratum of clay occupying this highest terrace, to be the separation between the fine grained-sand stone and the next superior formation, the conglomerate, which is succeeded by the coal measures.

The barometer at this point stood at 738.2 millimeters; temperature 28° centigrade, just 10 millimeters lower than at the top of the slate, which corresponds to a difference in altitude of 345 feet, which is the thickness of the fine-grained sandstone, or "Waverley sandstone." Add to the above 145 feet, and we have 490 feet, the altitude above Williams's. Above low water of the Ohio at Cincinnati, this height is approximately 672 feet.

Our descent into the head of lower Twin was more rugged than the ascent had been; lying over the stair like edges of the layers of sandstone, at an angle of 17 degrees, it was fearfully dangerous, and but for the sagacity of our well trained Oppelousas horse, would have been scarcely practicable.

The barometer, at the top of the slate, on the south side of the ridge, stood at 7479, 26° C. This, making allowance for the fall of the basal barometer during the same time, 0.25 millimetres, made a difference of only 20 inches in the altitude of the slate at the two opposite sides of the hill. After arriving again at the slate region, the sugar tree and its usual

attendants made their appearance, and continued to occupy the alluvions and moderate slopes quite down to Rockville. Nothing of peculiar geological interest occurs in this descent. There are at three points near the road side, "slate banks," as they are called, perhaps 70 feet high. These are very steep escarpments, where the slate, by disintegrating and falling off, leaves a clean bald view of the edge of the strata. The channels in the slate and limestone regions are mostly dry, except in times of floods. There being no beds of clay or stone sufficiently impervious to bear out the water, springs are scarce and the success of sinking wells doubtful. Within 3 or 4 miles of the Ohio river we found some little lagoons in the lowest places of the channel of the creek, at which we procured water, almost alive with small fishes, for our horse. At about 6 in the evening we arrived at Rockville, and took lodgings with the hospitable proprietor, Mr. Loughery. A barometrical observation was immediately made at high water mark, with which to connect the previous observations of the same day. It reads as follows:

August 14, 6, P. M., 754.5 millimetres; 29° centigrade.

I am aware that in my account of this little journey, I have gone into the details of an exploring tourist, but as I was in a kind of *terra incognita*, a peculiar region, I thought my notes, pretty much as I put them down at the time, might not be uninteresting or uninstructive.

The fine grained Sandstone at Rockville.

This is the stone used at Cincinnati and elsewhere, for building. It is procured from Waverly, Rockville, and several other localities. "It is the best building stone in the State," and is scarcely surpassed in the world. The grain is so exceedingly fine that it appears when smothed almost compact. Its color is a drab and very uniform, varied a little occasionally by iron stains. Its fracture is dull and earthy, but so fine and soft as to have a peculiarly velvety appearance. It works freely and generally endures atmospheric agencies with little change, except that it blackens somewhat from a decomposition of sulphuret of iron intimately blended with it. It endures the fire and answers well for the hearthstones of furnaces. Its substance is chiefly an alluminous and silicious deposite, almost wholly destitute of any calcareous matter. It lies in layers or strata nearly horizontal and varying in thickness from a few inches to three or four feet, seperated mostly by simple joints or seams, having a little clay in them; sometimes by a stratum of clay, and in two places traversed by a stratum of shale or soft slate 15 feet thick.

While I was at Rockville, the weather was showery, and the barometer so fluctuating that I with difficulty obtained satisfactory results. In the course of eight hours I found it had changed so much by the weather as would have amounted to near 100 feet of altitude, and the observations during that time were given up. When the weather had become more settled, I obtained a suite of observations, from which I deduce the following heights above low water at Cincinnati:

Top of the slate, - - - - - -	261 feet.
White ledge, - - - - - -	344
City ledge, - - - - - - -	410
Beautiful quarry, - - - - -	465
Iron stratum, - - - - - -	517
Top of the hill, - - -	542

Specimen sections will give the best idea of this valuable quarry, beginning at the bottom and proceeding upward, measuring each solid layer separately.

Specimen section at Loughery's Quarry.

1.	White ledge,	2 feet.
2.	Stone,	0.5
3.	Stone,	1.9
4.	Shale with thin shells of stone,	1.1
5.	Stone,	1.90
6.	Stone,	0.25
7.	Shale,	1.7
8.	Stone,	0.85
9.	Shale, variable,	2.00
10.	Stone interrupted and nodular,	2.00
11.	Shale,	2.20
12.	Stone,	1.00
13.	Stone interrupted, nodular, and variable,	3.00
	Amount,	20.40

Out of the preceding 20 feet and four tenths, seven feet are shale; leaving 13.4 feet of stone. Although the different layers of the sandstone are geologically very much alike; yet, the minute discrimination for practical purposes, makes important distinctions and confines the present demand for stone at Rockville very much to two layers; the "White ledge" and the "City ledge"—the one named from its color, and the other from the great consumption of it in the city of Cincinnati. The white stratum is the most perfect and beautiful stone in the quarry, but not so much consumed as the city layer, because it is harder to work. The Trust Company Bank in Cincinnati is built of it, and no structure in that city shows so fine a material. The upper parts of the sandstone deposite become more and more ferruginous and disintegrating, less durable and less beautiful, and from this general fact, I venture to give my opinion that the western escarpment where the bottom layers are accessible, as at Rockville, will furnish the better stone. The quarry at Waverly furnishes a good material, and I am not informed what part of the stratum is explored there.

The "*city ledge*" at Rockville, has a stratum of shale about 15 feet below it, and another of about the same thickness above it, the stratum itself being 2½ feet.

Specimen section of the "Beautiful Quarry" at Rockville.

This quarry, from the perfect parallelism, and, in many instances, the uniformity of thickness of the strata, and from the length and perpendicularity of the section which exhibits them, is well entitled to the epithet so common with the French, "belle" or beautiful.

The following is the section, beginning at the bottom:

1st.	Stone,	1.5 feet.
2d.	Eight layers, each about 1 foot,	8.0
3d.	Six layers, each about 3 inches, separated by 2 inches of shale,	2.7

4th.	Stone,	1.25 feet.
5th.	Shale,	1.20
6th.	Eight layers, each 3 inches, separated by 1 inch of shale,	2.7
7th.	Stone,	1.0
8th.	Stone,	.7
	Total,	19.15 feet.

Out of the above 19 feet, there are only little more than 2¼ feet of shale. This accounts for the exact lines in which the layers present themselves; for I have found the undulation of rocks about in proportion to the soft material which is interstratified. The strata above this are on an avarage 1 foot thick, separated only by seams, in one instance 3 feet 4 inches.

Discoveries at Rockville.

Just above the Beautiful Quarry the stone are marked with a vegetable impression as if of sea weed having regular stems with plumose branches recurred in such a manner as to exhibit beautiful curls or cirri. The rocks above the "Beautiful" are more ferruginous than those below, and contain pyritous nodules sometimes globular. One rock on splitting "discharged a cannon ball" fourteen inches in diameter.—They exude a moisture which effloreses abundantly into a bitter salt, probably the sulphate of Magnesia, Epsom salts. All of the shales included in the Sandstone series do the same. The iron stratum is near the top. In ascending the south branch of the Scioto Brush Creek, I picked up a nodule of iron ore filled with entrochites and bivalve shells! On ascending the hill at Rockville I found a detached mass one and a half feet in diameter of the same character; and on ascending the upper quarry I found a stratum in place. It is about 13 inches thick, light, porous, tender, ferruginous, and abounding with castes of two species of enchrinitral vertebræ. 1st. With joints unequal, about one fourth of an inch in diameter. 2d. With joints equal about half an inch in diameter, thin edged, and radiantly grooved with about 48 radiant lines.

There are also moulds of numerous bivalve shells, beautifully and distinctly marked. Indeed this stratum seems to be a mass of moulds or crusts of fossils made of iron ore, perhaps originally pyritic, with the interstices filled with brown ferruginous sand. This fossiliferous stratum is highly instructive, as it shows that the sandstone has been formed in ocean depths as well as the limestone below.

It seems by the above heights, that Mr. Loughery has 280 feet in thickness of the sandstone. Say 140 feet of this is solid workable stone. An acre of such a quarry, at 12½ cents per perch, is worth fifteen thousand and four hundred dollars. The limited demand; the selection of particular layers, and the local advantages and precedence which our quarry must have over others, render such a calculation as the above, rather a matter of curiosity than an expression of any thing immediately available. There are quarries of sandstone, probably of the same quality as those at Rockville, several miles below that place, and all of the way up Brush creek on the eastern side of it; but Mr. Loughery's has one advantage over the whole of them. It is very accessible by navigation, and is so bold an escarpment that it is easily stripped of rubbish which is thrown

down the hill. Few persons unacquainted with quarrying, are aware of the great draw-back occasioned by "stripping," excavating, or clearing away rubbish.

Observations in the North part of Adams, and the contiguous parts of Highland counties.

On my way from West Union to Locust Grove, we were very hospitably entained free of expense by Mr. Summers, the present proprietor of the Marble Furnace. At or near this place, the upper layer of the flint limestone crops out and is an uncommonly fine building stone, with which the foundation of Mr. Summers's house has been laid. At this place also, the bed of Brush creek is no longer on the blue limestone, but within the lower layers of the flint limestone. Mr. Summers' spring, like many others in this part of the country, is a copious one and of an excellent quality of limestone water. I believe it comes from the bottom of the great marl stratum. Its temperature on August 23d, was 54 degrees of Fahrenheit's scale.

Our road from Marble Furnace to Locust Grove, was over the cliff limestone, with a soil producing a forest of oak timber.

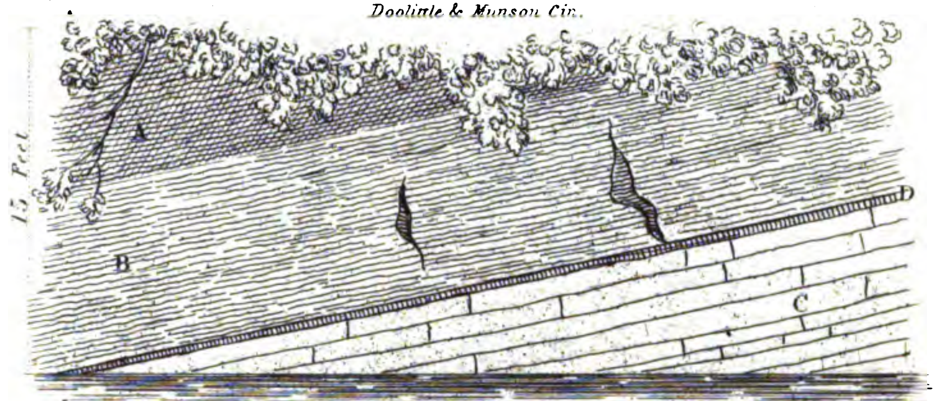
Locust Grove lies in the southwest corner of Benj. Temple's survey, No. 3077. Geologically it occupies the cliff limestone at a lower level than its top. We proceeded immediately, in company with Mr. Cannon, to examine the sulpher springs in the neighborhood. Massie's spring is about two miles northwest of Locust Grove, and north of Crooked creek. As we decended into the channel of Crooked creek, I did not find as I had expected, the great marl stratum. Its place seems to be occupied by thin layers of limestone. Although we travelled on that level which should have presented us with the cliff limestone, yet we were surprised with its total disappearance as we approached the spring, and in its place was found the sandstone in large upturned and broken masses. In short, it became evident that a region of no small extent had sunk down several hundred feet, producing faults, dislocations and upturning of the layers of the rocks. The spring has every property of an excellent sulphuretted water; on the west side of it, is a grey limestone, the cliff stone rising about 15 feet, while at the opposite side of it is slate dipping 30 degrees to the east. Nor is this a mere local deposite, for I found it continuous and at the same dip for five or six hundred feet. Proceeding eastwardly, we came to sandstone, a hill indeed composed of it. Over this hill there had been a cart road for hauling down the oak bark, and as the next sulphur spring lies beyond it, we determined to drive over it. In this movement, a gentleman residing in the neighborhood, mounted on horseback with his axe on his shoulder, proceeded in advance as a pioneer, to clear away bushes and wind falls. Mr. Cannon took a seat in my wagon, and my son brought up the rear on horseback. Our progress was slow; for many bushes and fallen trees had to be removed by our pioneer. At the top, the Barometer stood at 7438. At the spring it had stood at 7493. The difference corresponds to a height of 190 feet above Massie's spring. The plants on this hill are those of the sandstone formation, as the huckleberry and the chestnut. Descending on the opposite side, we came to Mershon's sulphur spring. It comes out on the left or east bank of a small run having limestone on the east, and slate on the west of it. The slate at this spring dips in a direction opposite to that at the first spring, at the rate of 16 degrees, as follows: Line of bearing, N. 6 degrees W.—Line of dip, W. 6 degrees S.

No.14

SECTION in the left bank of STRAIGHT CREEK a few rods North of ADAMS CO. line.

BY JOHN LOCKE.

Doolittle & Munson Cin.



A .... Soft Shale.
B .... Slate.
C .... Sandstone.
D .... Decomposing Pyrites.

As the top of the slate is found here more than 300 feet lower than in the strata in situ in the surrounding knobs, and as these strata are broken and upturned, it is evident that this mountain at some remote period of time, has sunk down from its original place, and I ventured to call it the "*Sunken Mountain*." At Mershon's spring are found the Ludus Helmontii or Septaria of the slate. A few rods lower on the same run is the "White Sulphur Spring," like the other two, coming out at the immediate contact of the slate and the limestone.

The several Springs compared.

Massie's spring was formerly the property of the late Col. Massie of Chillicothe, and several buildings were erected by him, in order to make it a convenient "watering place," several cabins and a bath house, all of which are now entirely demolished. A section of a hollow tree called a "gum," has been sunk as a curb, in which the water wells up. It has all of the usual qualities of a "sulphureous water;" the smell, the perfect transparency, the black mud, the sulphur film and the milky precipitate, as it runs off. The temperature is 54½ degrees, and it discharges about five quarts per minute. The spring has one peculiarity. The mud at the bottom, though black, has a tinge of purple, and in parts looks reddish, and hence it has been called the "Red Sulphur Spring."

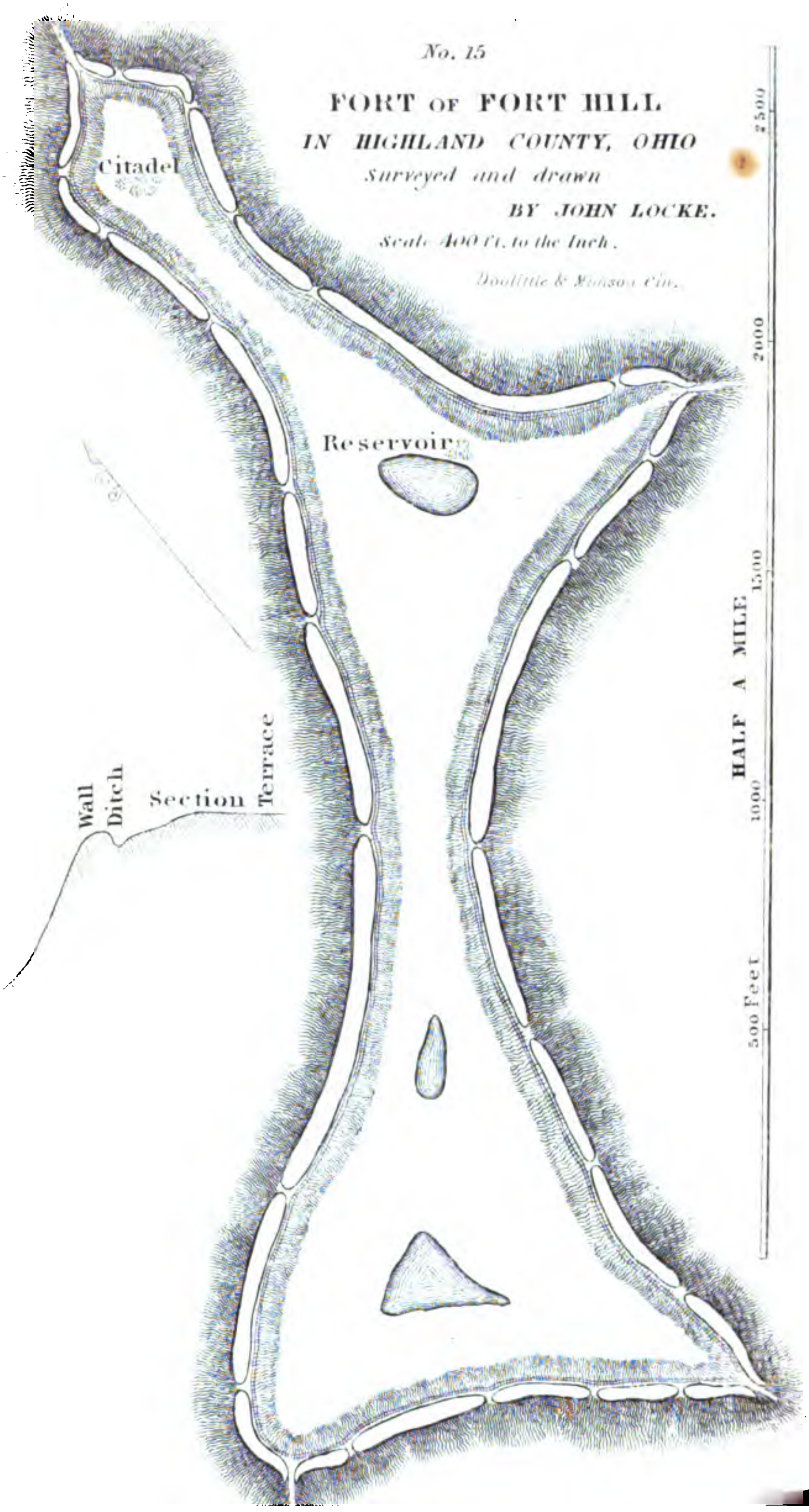
Mershon's spring has the temperature of 55 degrees, and is somewhat inferior to Massie's in the quantity and quality of its water. What is called the White Sulphur Spring, coming out from underneath a high bluff is rather colder than either of the other two, being at the temperature of 54 degrees. It is rather a chalybeate than a sulphureous water, and wanting the black mud at the bottom, which is clayey, has received the name of *White* Sulpur Spring..

On travelling from Locust Grove to Sinking Spring, I found that a tract large enough for a township, reaching within a mile of Sinking Spring and extending several miles up Straight creek, was in the same manner dislocated and sunken about four hundred feet, having been originally knobs of the height of those contiguous. In the bed of Straight creek near Adams county line, the slate although at a level of 150 feet below the cliff limestone, is found with its whole thickness of 250 feet, outcropping at an angle of 29 degrees, and plunging southwestwardly to an unknown depth, re-appearing again however, in the distance of one or two miles, with its dip in the opoosite direction. On the East side of Straight creek near Adams county line, the upturned strata exhibit the following section, in which I was surprised to find slate *above* the sandstone, but I presently discovered that slate to be a stratum which traverses the sandstone as found at Rockville, both above and below the "city ledge." (See plate No. 14.) Sinking spring is in the cliff limestone, and about 150 feet above the water of Brush creek, which is here closely and deeply channeled in the cliffs, and 430 feet above the low water of the Ohio at Cincinnati, or 297 feet above Lake Erie.

Ancient work in Highland county.

While on the geological examination of Adams county, I observed from the heights of several mountains, there called "knobs," a conspicuous and insulated elevation several miles to the northwest, which for the purpose of some topographical sketches I determined to visit. I found it to be near Sinking Springs, on the road from Maysville to Chillicothe, and within the limits of Highland county. It is called in the vicinity

"Fort Hill," from an ancient work which occupies the top of it. After groping my way without a guide one mile through a bye-road, and another mile on foot through a forest, I reached the top of it, which is a level table of 35 to 40 acres. Here I was surprised to find an ancient work, in many respects surpassing all others which I had seen in Ohio. The mountain is 500 feet above the bed of Brush creek, which washes its base, and 800 above the level of low water in the Ohio at Cincinnati, and mostly of solid stone interrupted only by thin layers of clay and marl. Yet it is covered by soil and with forest trees. The rocks proceeding upward are in height ascertained by the Burometer, 150 feet of cliff limestone, 250 feet of slate, and 100 feet of freestone, covered by about 20 feet of clayey soil, being a natural stratum of slate and clay traversing the freestone formation, the upper part of which is here wanting. This terrace of soil produces a luxuriant forest of sugar trees, elm, poplar, oak, chestnut, &c., some of which are 21 feet in circumference. The whole is enclosed with a ditch and wall, which is one mile and five eighths long, and flanked by four bastions. The ditch is 64 feet wide, and by descending at first abruptly, gives the appearance of a second or interior wall. From this it slopes gradually to the immediate foot of the wall where it deepens suddenly again. The base of the wall is 40 to 60 feet; and its outward slope is made to coincide with the slope of the hill, which all around is about 150 feet, almost inaccessibly steep. And below that, still a steep hill to the base. Thus by nature and art the outward defence is a wall of stone 100 feet in perpendicular height, down which the defenders might roll the broken fragments of freestone, abundant in the entrenchment, each man with his hands alone being thus an efficient piece of artillery. The height of the wall from the bottom of the enrenchment is generally from 4 to 9 feet, but in some places it is 20 feet. The substance of it has been determined by the nature of the materials excavated, and consists of stone mixed with earth. In many places the ditch has been excavated by quarrying through the solid freestone. In one place only I saw the stone laid in rugular range work, like masonry, and this might have been the natural strata of freestone left in the wall by entrenching within. I happened to have along with me, my miniature instruments for surveying, of which my microscopic compass, made by Troughton and Simms, is the principal; with these I commenced immediately a survey by "meandering." This was a difficult task, for the large trees and an abundance of pawpaw bushes, did not permit us to range more than 150 feet at a time. I had no assistance except that of a lad, my son, who accompanied me. Yet excited by the subject, I made not even a halt, until after a whole day of fatigue in the heat, without food or water, we had by 49 lines of course and distance, come round to a "sugar tree, the place of beginning." I had not the least idea of the form of the work until I drew the plot, which closed within 20 feet. It consists of four unequal sides curved inwards, and meeting in four acute "salient angles," at which there are peculiar open bastions, the walls curving outward a little, like the lines of a parenthesis, and, finally, running parellel to each side of a road which enters at the very angle. This road comes up along a ridge less precipitous than other parts of the hill. The north bastion is peculiar and constitutes the *citadel*. The gorge to it is long and narrow. The bastion is large and having four concave sides has three little bastions, thus constituting a complete fort within itself. The wall girts the hill at all points below the level of the table within, but at the citadel the ditch commences with a perpendicular precipice of freestone, 20 to 30 feet high, leaving the interior like the top of a castle girt with a moat and wall at


No. 15
FORT OF FORT HILL
IN HIGHLAND COUNTY, OHIO
Surveyed and drawn
BY JOHN LOCKE.
Scale 400 ft. to the Inch.
Citadel
Reservoir
Wall
Ditch
Section
Terrace
HALF A MILE
500 Feet
1000
1500
2000
2500

its base. At distances nearly equal, there are in the whole line of wall 28 openings or gates. These were originally, in all probability, closed by woodwork, and the wall itself surmounted by palisades. In the midst of the enclosed table is a pond, which, although it had recently been drained of three feet of its usual contents, still, on the 25th of August, it contained water. A chestnut tree, six feet in diameter, standing on the top of the wall, served to mark its antiquity. Counting and measuring the annual layes of wood where an axeman had cut into the trunk, I found them at nearly 200 to the foot, which would give to this tree the age of 600 years. A poplar tree seven feet in diameter, standing in the ditch, allowing the thickness to the layers which I have found in like poplars, 170 to the foot, would give nearly the same result, 607 years. This work differs from all others which I have seen, except that at the mouth of the Great Miami, which I had lately surveyed. A figure of this last work accompanies Gen. Harrison's address on the aborigines, lately published in Cincinnati. The two works are as perfect a counterpart of each other as the ground and other circumstances would permit, with the difference, that Fort Hill is superior in magnitude, strength, and romantic site, to that on the Miami.

Probably no place in Ohio, and few places in the world, are better calculated by nature for a "strong hold" than Fort Hill; and no plans of "ancient works" yet discovered, show more skill in the design or labor in the execution. Yet, the traveller, who from the above sketch shall be induced to pay the hill a visit, will likely be disappointed—for the dense forest will permit him to see only a few rods at a time, and will not allow him to be impressed at once with its general grandeur. It is probably on this account that even the surviving pioneer companions of Gen., Massie, the patriarch of this part of the country, knew nothing of this curiosity. The outline of the fort is that of a naked leg and foot, with a slender ankle and sharp heel, being cut off at the lower part of the calf by a line curved downwards. The two corners of the shin and calf and the heel and toe form the four bastions, and the middle joint the citadel. See plate 15. In a kind of saddle of the hill, just at the top of the slate, was apparently the burying place, where a heap of stones was accumulated; not such as abound there in situ, but limestone which must have been brought up from the valleys below. The specimens had evidently been selected for strong peculiarities—some being the fantastic concentric nodules, filled with quartz or calcareous chrystals, others containing peculiar and well marked fossils, others again were of the spongy and frost-bespangled layers of the cliff: indeed they seemed to be a rude collection of geological specimens, which I studied with interest, as presenting the extraordinary features of the valleys below. At Mr. West's, about four miles distant, I found a very large collection of similar curiosities, with the addition of all the more striking kinds of boulders, especially those which had chrystals, mica, tourmaline, or any thing brilliant attached to them. Mr. West, who is a cousin of Benjamin West, the historical painter, informed me of another extensive work still further westward, but I had not time to visit it.

Ascent of Pine Hill.

I have already mentioned the range of slate knobs, seen eastwardly from Locust Grove. Some of these approach within two miles, as is the fact with Pine Hill. Our road to Pine Hill lay through a forest of oak, in which the staple of this region, lumber, was finely represented. Here I saw several productions not familiar to me. One was the service tree,

or juneberry, which I presume to be a Mespilus, possibly the Canadensis; but here it grows to a tree 12 to 18 inches in diameter. A shrubby Hypericum was another. This grows underneath the oak forest, and attains the height of 4 feet, with large yellow blossoms.

Advancing across several runs which cut their channels through the thin soil, quite down to the cliff limestone, we came to the immediate ascent, where driving our horse into a thicket for concealment and security, we took to our feet. Immediately the two species of huckleberry, characteristic of the slate and sandstone, made their appearance. The sides of the hill, consisting of loose plates of disintegrating slate, are almost barren, but bear a few pines, which give name to the hill. The top is capped with sandstone, and bears abundance of the same grass found on Grassy Hill.

Bearings taken on the south brow of the hill.

1. Hill, - - - - - - - -	311°
2. Knobs, Fort Hill? near Sinking Springs, - -	322½°
3. Locust Grove, Cannon's N. chimney, - - -	242½°
4. "Grassy Hill?" near Steam Furnace, - - - -	195½°

The view from the summit of Pine Hill in the western half of the horizon, is as extensive as an elevation of four hundred feet could give—the horizon appearing to die in blue distance like the farthest verge of the ocean. To the east it is limited by the Sunfish mountains, which are perhaps two or three hundred feet higher than my station. There is a valley among those mountains in which heads one of the branches of Scioto Brush creek. It looks spacious and beautiful, but from a cluster of pine trees in the bottom of it, I infer that the soil is rough and worthless. Having made our observations, we descended to our wagon and horse, which we found in order. We had detached the horse from the wagon and tied him to a tree, where he had amused himself in *eating the slate soil*, barking the trees, and whisking off the enormous "horseflies" which swarm about animals in those regions, lancing them to such a degree as to draw blood copiously. The young gentleman from Locust Grove who volunteered as my guide, told me that strange animals will always eat the slate earth. It contains a variety of saline matter, which is probably palatable to them. So far my remarks concerning my horse are no digression from the subject of Geology. The approximate height of Pine Hill above low water of the Ohio, as is indicated by the barometer, is 679 feet.

Is there any coal in Adams county?

This question was repeatedly asked by the inhabitants. It will be of great use indirectly to the people, to inform them where coal is *not* to be found. It will save a useless waste of time and money. So far as discoveries have progressed, no coal has ever been found in any of the sorts of rocks below the coarse sand stone called "conglomerate," which lies immediately above the "fine-grained sandstone." Although I did not find this sort of rock in Adams county, I took the liberty to represent it in the top of the right hand end of the "SECTION," and above it a layer of coal, the lowest that has ever been found. If this layer of coal were extended to the west side of Adams county, it would ascend, in consequence of the "dip," to a place more than a thousand feet above the

surface, where I have marked it on the left hand edge of the map. If coal can be found at all in Adams county, it will be in the tops of the hills or mountains in the extreme northeastern part of it, called the Sunfish hills. Mr. Leedom informs me that he thinks he has seen the conglomerate (a coarse sandstone, with pebbles in it) on those hills; and if this can be found say 200 feet thick, it is barely possible that coal may cap the tops. The slate or shale is very tempting to coal hunters. It is often jet black, and contains so much bitumen that it will burn. I believe there is coaly matter diffused through the whole mass of the slate; but unfortunately it is not any where sufficiently collected together to be workable.

Rock Oil, or Petrolium.

I have noticed that all of the rocks above the blue limestone and below the sandstone are bituminous, and occasionally have cavaties filled with Petroliam, which when the rock is broken will flow out like a thick brown oil. There is a spring on Rocky fork of Scioto Brush creek, represented in the extreme eastern edge of the map, which discharges constantly a quantity of Rock oil. This floats on the surface, and is often gathered there for medicinal use; thus I am informed, for I did not visit the locality.

Catalogue of Minerals found in Adams county.

Rocks and Earths.

Blue Limestone; Clay marl; Flinty Limestone; Sandy Limestone; Calcarous spar or clear, glass-like Crystals of limestone; Hydraulic limestone, being a compound of lime, clay, fine sand, and iron; Quartz crystals, which will scratch glass; Chert or Flinty nodules, often broken into sharp fragments; Sulphate of lime, Gypsum, in small quantities; Sulphate of Baryta, heavy spar, rare; Slate or shale; Clay; Sandstone; Red ochre; Bright yellow ochre:

Ores.

Iron ore, workable, but limited and somewhat exhausted.

Sulphuret of iron, pyrites abundant. This ore is brilliant, often as bright as gold itself, sometimes white like silver and occasionally by partial decomposition, black and bronze like. Nothing amuses and deceives the uninitiated so much as this worthless ore. It may be distinguished by the following characters: It is hard, will scratch glass, brittle, and may be pounded to powder, by heat gives out a sulphurous smell, and turns to a brown brittle substance. It sometimes decomposes and forms copperas blende, sulphuret of zinc, in brown nodules, rather rare.

Soluble Salts.

Sulphate of magnesia, Epsom salts, a common efflorescence.

Muriate of soda, common salt, very sparing and mixed with other salts in the springs.

Sulphate of alumina, allum, abundant in the slate.

Sulphate of iron, copperas, also abundant in the slate.

Combustibles.

Petrolium, rock oil.—Bitumen in the rocks.—Sulphur from the sulphur springs.—Sulphuretted hydrogen, from the same.

Concluding Remarks.

Adams county, although partly broken and with rather a thin soil, yet with good management may be made to produce good wheat crops.—Great advantages would probably arise to the farmers by improving their breeds of stock and by the raising of sheep. The broken lands, covered with oaks and hickories, afford abundance of mast for hogs; and yet so miserable and worthless a breed of swine, which are all snout and legs, and can never be fattened, are in possession of the range, that little or no advantage can be derived from them. That breed which supplies the great pork market of Cincinnati might be introduced there to a very great profit to the people.

Adams county has never been brought into due notice for its salubrity and numerous resources for recreation and healthful amusement. Its surface is varied and romantic and often picturesque: its springs singularly diversified and abundant, affording every variety of clear cool limestone water, chalybeate, sulphureous, saline and soft freestone water. The wild forests and *Brush* wood thickets, are as diversified as the strata of rocks, and abound with small fruits and all manner of game, consisting of the squirrel, the rabbit, the oppossum, raccoon, and the deer, the quail, the pheasant (grous,) and the wild turkey. It is surprising that with all of these allurements, and it certainly has them, it should not attract the fashionable from Cincinnati and Chillicothe; when it is so much more accessible than the usual places to which they resort. The dyspeptic of Cincinnati might in a few hours be at Rockville, and try the efficacy of a fine chalybeate, there destitute almost entirely of lime. Or the newcommer from the east, suffering too severely by the use of hard water, might there, by using soft water, be clear of the cause of his complaint.

It was not probably expected that any thing more valuable than quarry stone, marl, hydraulic cement, &c. would be found in the southwestern quarter of our state. The geology of the blue limestone region is so very uniform that very little money need be expended in its examination, unless the organic remains be examined and the soils analized with reference to their agricultural improvement, for some of them on the terraces are on the decline. Yet it is certainly worth the cost to give to the people a rational knowledge of the strata of the common rocks even, in such a manner that they can, as it were, *see into the earth* at any point, and tell what rocks may be found at any given debth for five hundred or a thousand feet. This I believe I have done for Adams county in particular. And a work of this kind once done produces forever afterwards its beneficial results. Even the negative results are of positive value.—It is certainly important to draw people from absurd projects and direct their energies to pursuits of substantial utility; to stop the gold hunter, the coal hunter, or the salt borer, from a useless expenditure of time and treasure, and send him to new quarries of lime or building stone, to beds of marl for the improvement of the soil, and to the introduction and management of suitable crops and stock, sources of wealth and happiness more certain than mining.

ACKNOWLEDGMENTS.

In avoiding personal narrative I have omitted to make due acknowledgments for the various favors which I received in my several journeys. Traveling with a wagon in by-roads, often into the woods destitute of roads, laden with specimens of the rocks examined, and always encumbered with instruments for observation, leaving my horse frequently, to make examinations on foot, and occasionally obliged to drive in the night, I was liable to numerous accidents which did not fail to occur. In one instance my horse being left was attacked by the united force of twenty-eight swarms of bees—broke his harness, drew the wagon a quarter of a mile bottom upwards, and strewed the road with specimens; it was a sad labor to get things righted again. On another journey I was overtaken by darkness in the woods, and a tree having fallen across the road my horse leaped over it and drew the wagon into the knarled branches from which it was impossible for me to extricate it; a journey on foot through mud knee deep, in the blackness of midnight, to the nearest inhabitant to procure assistance, was the only chance of escape. Mr. Williams, near College Corner, Butler county, although his family were all sick with the measles, enabled me to get forward to the next inn.

On a third occasion my horse took fright in the night at a white boulder in the road, sprung suddenly forward, broke his harness, but had started the carriage into such a speed that as I reined him the shaft pierced his body with a dangerous wound; in his agony he gyrated round and round, stripped the harness entirely from his body, trampled it into the mud and upset the carriage. The temporary pain from the fall and shock, was severe, but I had sustained no serious injury—my barometer, strapped to my back, escaped unbroken. There were lights in a house and grocery near, I applied for assistance, and heard the voices of *men* in the grocery as I approached, but when I knocked, the lights were instantly extinguished, and I was told by some females in the house there was nobody there to help me, and that I must "go to the brick house." But I could get no directions to the "*brick house*," only it was in a field the other side of the way. My disgust at the treatment prevented me from urging very particular inquiries; and I presently found myself wading in the mud of the road scarcely darker than the atmosphere above it. A light at a distance gleamed the hope that it proceeded from the "brick house." I directed my course recklessly towards it; left the road, entered the field, waded a muddy brook, but had the mortification to perceive that the light proceeded from a brush heap in the field. On scanning the visible darkness I discovered the faint outline of the "brick house," but all in darkness and silence. I approached, knocked, made known my case, and heard the call, "My son, you must get up, here is a stranger in trouble." The son came with a lantern; and after sheltering the wounded horse, we found the mother and daughter, an interesting young lady, preparing a hot supper for me. The intelligent reader will feel that I need pay this family no higher compliment. To a geologist suffering as I was, it must always be interesting to discover *specimens* of hearts made of *flesh*, not of *stone*. This *locality* is on the east side of the Miami, about five or six miles north of Dayton, where the "brick house" stands a few rods to the west or left hand side of the road. The appellative "decent," "decent" Dougherty, applied by the neighborhood to the

benevolent farmer, certainly in his case expresses very creditable qualities. I wish the epithet were equally well deserved by a much larger portion of the world.

At Dayton, my acknowledgments are especially due to Chas. Anderson, Esq. Col Partridge, Mr. John Vancleve, and Mr. Forrer, for their polite attention and assistance in the accomplishment of my duties in that neighborhood. At Hamilton, the same is due to Mr. Wood, Mr. Bibb, Mr. McBride, Mr. Erwin, and to several of the physicians of that place, who did me the honor to call upon me and accompany me in some of my excursions. Mr. McBride has a very interesting collection of the antiquities and fossils of that neighborhood, to which he gave free access. I proposed and actually commenced some drawings and castings from them for the State cabinet, but found it would consume more time than was consistent with the other duties to which I had been ordered. It is fortunate for the history and science of the west that a few amateurs like Mr. McBride have preserved from oblivion many unique and valuable specimens.

In Adams county I received every facility and assistance from the county officers, Gen. Darlinton, county clerk, Mr. Cole, auditor, and Mr. Smith, recorder. This last named gentleman took a deep interest in the survey, made several excursions with me, conducted me to interesting localities, and assisted me in my observations. Mr. Smith being an editor, published to the inhabitants a notice of the survey which induced many of them to bring specimens of ore and of rocks, and receive from me such information as I was enabled to give them.

In several instances I was entertained for several days free of expense, and as my salary was so small that I did not receive, clear of expense, the wages of a day laborer, this was a substantial kindness. I am under such obligations to Messrs. Summers, of the Marble Furnace, Fisher of the Forge, Stuart of the Brush Creek Furnace, and Loughery of Rockville, and Mr. Coxe four miles below Rockville. At many other places the charge was so trifling as to be singularly contrasted with the extortionous demands made at the taverns in some upstart towns. I met with unkindness in but few instances. One young man, a hireling, who could not conceive of any other motive of action than direct specu lation, imagined that I was extracting something precious from the rubbish and marl which had been dug from a well on Bell's hill, and threatened me with exclusion from the "premises," or with a demand of recompense for what I was taking away. It was not in his mind to conceive it possible that the legislature had sent a man to examine people's farms and to inform them, *for their own benefit*, of all the discoveries, which he might make. The weather-beaten, hedge, and crag-worn appearance of the travelling geologist is not calculated to give common people the impression of a commissioned "officer of state," sent by the governor to serve them. Some brief printed proclamation signed by authority, to be distributed among those people who have never heard of the survey, might be useful, to dispel those suspicions which honestly arise by confounding the geologist with the numerous itinerant speculators who are constantly defrauding the people under all varieties of pretences; and, to give them such information as to induce them to ask of the geologsit such information as would at least prevent them from wasting their time in idle and absurd explorations.

JOHN LOCKE,
Second Geological Assistant.

APPENDIX

TO

DR. LOCKE'S REPORT,

Containing the record of barometrical observations made during his examinations.

The taking of heights by the barometer is specified in the act authorizing the survey of the State of Ohio; and although I was not ordered by the principal geologist to execute such a work, yet, as I had a pair of excellent "Bunten's brass-tube barometers," I brought them into use, and found great advantage in doing so. The interests of the survey seem to require that each field surveyor should have a pair of these barometers, one to be used stationarily at some point, the altitude of which is well established; and as near as possible to the theatre of active duty, its altitude to be noted at least three times per day. This I would call the *basal barometer*, and the observations made with it, *basal* observations. The other should be noted at the various points, the altitude of which are to be ascertained. The object of the basal observations is to determine what part of the changes in the movable barometer are due to the changes in the atmospheric pressure, and thus to be able to see what is due to difference of height. But when the traveler ascends or descends in a few minutes, or even within one or two hours, from one point to another, the difference of altitude will generally be indicated with sufficient accuracy without reference to the basal observations, especially through the tranquil atmosphere of summer, when the basal barometer scarcely fluctuates for several days, or even weeks.

There were, in my operations, no provisions for basal observations in the counties examined; and I have substituted those of my friend, Prof. Ray, made at the Woodward college, 150 feet above low water of the Ohio, and about 17 feet above the level of Lake Erie. His barometer, from the effect of capilarity, stands 1.8 millimeters lower than my own, which, being on the syphon principle with both legs of equal diameter, needs no correction for capilarity. Prof. Ray's altitudes are noted in English inches and hundredths, and his temperatures in the degrees of Fahrenheit; while my heights are in the French millimetres, and the temperatures in the degrees called Centigrade. If any person wishes to compare them, he can reduce my barometric altitudes to inches and decimals by the following rule: *Multiply the four figures noting the observation by* 3938, *and point off six figures of the product for decimals.* To reduce the degrees of the Centigrade thermometer to those of Fahrenheit's scale—rule: *Multiply by* 9, *divide by* 5, and add 32.

Basal or stationary Barometrical Observations, made at the Woodward College, Cincinnati, 150 *feet above low water of the Ohio, by Professor Ray.*

DAY.	5 A. M.		1 P. M.		9 P. M.		DAY.	5 A. M.		1 P. M.		9 P. M.	
	Bar.	Ther.	Bar.	Ther.	Bar.	Ther.		Bar.	Ther.	Bar.	Ther.	Bar.	Ther.
		°		°		°			°		°		°
May 8	29.24	42	29.24	51	29.24	42	July 19	29.45	75	29.42	97	29.40	82
12	29.38	45	29.35	68	29.30	50	20	.41	75	.41	92	.36	75
13	.24	38	.24	76	.19	63	21	.38	74	.38	87	.38	75
14	.25	57	.19	81	.23	61	Aug. 8	.48	74	.47	96	.46	80
15	.41	56	.43	87	.41	71	9	.44	76	.42	96	.44	81
16	.41	60	.57	84	.32	72	10	.44	76	.40	97	.37	82
22	.18	53	.29	63	.35	54	11	.38	76	.34	86	.33	75
June 4	.18	58	.11	87	.04	67	12	.39	70	.45	83	.44	73
6	.08	53	.11	71	.15	60	13	.46	62	.48	86	.50	72
7	.19	54	.25	81	.25	56	14	.55	62	.52	88	.49	73
8	.36	55	.37	86	.39	72	15	.41	70	.29	85	.24	72
9	.44	63	.45	90	.46	75	16	.22	68	.25	77	.29	69
July 5	.37	73	.39	94	.42	74	17	.32	65	.30	85	.29	73
6	.48	64	.48	82	.48	72	18	.31	64	.34	83	.37	70
7	.43	66	.43	84	.43	76	19	.44	64	.46	87	.45	75
8	.46	71	.45	93	.44	82	22	.56	66	.52	96	.52	79
9	.43	72	.39	95	.35	83	23	.53	73	.50	97	.47	78
10	.35	77	.31	94	.26	83	24	.47	70	.47	95	.42	78
11	.26	79	.29	88	.32	71	25	.40	70	.36	94	.33	79
12	.36	66	.41	74	.47	64	26	.44	69	.45	85	.46	71
13	.51	60	.54	81	.56	65	27	.42	60	.35	93	.28	78
14	.60	59	.57	87	.54	72	Sept. 1	.33	62	.37	76	.42	62
15	.44	70	.44	89	.44	74	2	.47	49	.50	74	.52	56
16	.43	70	.41	90	.39	76	3	.55	45	.54	75	.54	56
17	.43	70	.43	94	.43	79	4	.59	47	.60	83	.61	59
18	.45	73	.45	94	.45	81	5	.62	50	.64	83	.61	66
							6	.63	53	.62	90	.61	64

Barometrical observations made for determining altitudes, by John Locke, the heights being noted in tenths of millimetres, and the temperature in degrees of the Centigrade scale.

Day.	Hour.	Bar.	Ther. Degs.	Place of observation.
				Chester to Hamilton, 10 miles.
May 8	9 a m	7408	9.5	2½ miles east of Chester, in Butler county, [top of a hill.
		7457	9	Bottom of same hill
				Hamilton to Eaton and Dayton.
12	12 a m	7461	9.5	Mr. Beckett's house, Butler county
	6 p m	7366	9	Ratcliff's tavern, Preble county
13	11 a m	7406		One mile above Camden, at the water edge
		7377		Top of the bank of Paint Creek
		7410		Water edge of Paint Creek
14		7403	24	David Bick's, 15½ miles east of Eaton
		7377	25	Tavern on hill, 18 miles east of Eaton
	6 p m	7453	23	Second story of National Hotel, Dayton
15	9 a m	7472	20	Same place
	12 a m	7436	28.5	Col. Partridge's quarry, 3 m's from Dayton
		7444	28	Blue limestone below the quarry
		7439	28	At the kiln below the cliff
	1 p m	7422		At the quarry, again
	3	7465		At National Hotel, again
				Dayton to Light's quarry, 7 miles.
16	12 a m	7408	29	At Mr. Light's house, 7 m. north of Dayton
		7436	29	At the Canal, opposite Mr. Light's
		7402	29	Top of Light's quarry
				Dayton to Troy.
17		7360	23	Mr. George Fryeback's quarry
		7399	23	Canal east of Fryeback's quarry
		7362	23	Top of Cascade near Halderman's
				Dayton to Cincinnati.
22	6 a m	7388	12	Monroe, in Butler county
				Cincinnati to Madison, in Indiana.
June 4	3 p m	7344	23	Cross Plains in Indiana

Day.	Hour.	Bar.	Ther. Degs.	Place of observation.
June 4	5 p m	7329	23	Cooper's, near Cross Plains
5	8	7339	23	17 miles north of Madison, in Indiana
6	12 a m	7442	21	Bottom of Clifty falls
		7419	23	Bottom of coral stratum
		7478	21	At my room, 40 feet above high water
7	11 a m	7400	20	Hill above the quarry in Madison
	1 p m	7448	27	Coral stratum, Clifty falls
		7467	26.5	Creek below Clifty falls
	3 p m	7427	26.5	Bottom of the cliff proper
	4	7398	26.5	Top of the hill
	5	7411		Railroad
8	5 a m	7500	25	High water at Madison
				Cincinnati to West Union.
July 6	12 a m	7450		3 miles east of Newtown
	5 p m	7440	27	Withamsville, 15 miles east of Cincinnati
	6	7446	20	Dr. Hopkins', in Amelia, 20 m. east of Cin.
7	9 a m	7454	27	Bethel, Clermont county
	11	7434	27.5	8 miles east of Bethel
	1 p m	7444	30	Bald Hill, west bank of White Oak creek
	4	7499	29.5	Low water, White Oak Creek
	5	7429	27	Wilson's inn, Georgetown, Brown county
8	8 a m	7443	23	Decatur, Brown county
	9	7483	27	Edy run, 1½ miles east of Decatur
	10	7440	28	Fairview, 3 miles east of Decatur
	11	7480	29.5	Run, 3½ miles east of Decatur
	1 p m	7438	31	Hill, 5 miles east of Decatur
	2	7462	32	Run, 6 miles east of Decatur
	4	7425	30.6	West Union, Bradford's hotel
				Adams county.
9	7 a m	7430	24	Top of the quarry in West Union
	8	7469	30	Lick fork, Hillsborough road
	10	7419	30	Bradford's
	6 p m	7454	29	Top of flinty limestone in Beasley's fork
	7	7409	27	Top of Darlington's quarry
	7	7397	27	Room at Bradford's
10	4 a m	7391	24	Top of the hill half mile east of W. Union
	5	7432	23	Bottom of the hill, towards Decatur
	4 p m	7388	31	Flinty stratum in Beasley's fork
	5	7456	28	Blue limestone in Beasley's fork
	6	7487	29	At a school-house, high water of Ohio
	8	7487	28	Mr. Fisher's house, near the forge

Day.	Hour.	Bar.	Ther. Degs.	Place of observation.
July 11	6 a m	7496	25	Mr. Fisher's, again, high water of Ohio
	7	7441	26	Bottom of steep part of hill
		7424	26	Bottom of cliff stone
		7409	26	Bottom of coral stratum
	8	7397	27	Top of split rock
	9	7382	28	Top of the split rock hill
		7395		At "The Graves"
		7381	27.5	Hill top, again
		7396	28	Top of split rock, again
		7410	28	Bottom of split rock
	10	7423	28	Bottom of quarry below split rock
	12	7504	29	Water's edge, Brush creek, at the forge
		7498	29	Mr. Fisher's house
	4 p m	7458	33	At green burrh stone (shower approaching)
	7	7480	25	Cedar creek, at B. C. Furnace
		7464	25	Mr. Stuart's house, above the furnace
12	6 a m	7490	20	Same place
		7480	20	Bottom of cliff limestone
	7	7464	20	15 feet above iron ore bed
	10	7364	17	Waverly sandstone
	11	7338	16	Top of Furnace hill
	12	7464	20	Spring at the bottom of the slate
	1 p m	7504	20	Mr. Stuart's porch
	7	7528	20	Cedar creek ½ mile below the furnace
		7523	20	Cedar creek, just below the furnace
	8	7507	20	Stuart's porch
13	5 a m	7535	15	Same place
	6	7516	16	Bottom of quarry or cliff stone
	10	7540	21	Stuart's porch
		7562	21	Creek
	12	7545	28	Stuart's porch
	1 p m	7520	25	Bottom of cliff north of furnace
	3	7540	24	Stuart's porch
	4	7525	23	Bottom of quarry east of furnace
	4½	7494	22	Cliff top towards steam furnace
	5	7474	22	Hill-top, half way to steam furnace
	8	7485	19	At John Thomas's, at the steam furnace
14	5 a m	7490	12	Same place
	6	7515	18	Bottom of cliff at the slide
	12	7487	22	At the old ore bed
	1 p m	7394	26.5	Top of steam furnace knob or grassy hill
		7431	25.5	Top of slate ridge
	6	7515	26	Top of flinty stratum, Sample's hill
		7542	25	Water's edge, Brush creek
15	5 a m	7506	16.5	Flinty stratum, again

Day.	Hour.	Bar.	Ther. Degs.	Place of observation.
July 15	6 a m	7474	17	Bottom of Cliff limestone [sonville
		7461	17.5	Top of bank, and about 36 feet below Jack-
		7475	18	Bottom of cliff, again
		7407	18	Top of flinty stratum, again
	8	7533	25	Bottom of cliff opposite to Sample's tavern
		7540	29	Water of Brush creek at Sample's crossings
	10	7440	29	Three miles towards W. Union, from Sam-
	1 p m	7524	29	Waved stratum, near Treber's [ple's
	4	7411	29.5	Room at Bradford's
16	5 a m	7411	25	Same place
	8	7415	25	Same place
	9	7471	27	Bed of Lick fork, Chillicothe road
	10	7477	27	Nodular or cherty stratum
		7507	29.5	Waved layer [W. Union
		7478	26.5	Top of the blue limestone, 3½ miles from
	6 p m	7449	25	Bottom of flinty limestone, near Jenning's
	7	7463	25	Bed of Lick fork, again
	9	7404	25	Room at Bradford's [deen
17	1 p m	7537	30	High water of Ohio, Campbell's hotel, Aber-
	6	7533	29	Same place.
				Cincinnati.
				[water of O.
23	1 p m	7507	26.5	2d story of my house in Cin. 120 ft. abo low
	2	7471	29	Thick layer of stone above Judge Bur-
	3	7448	28.4	Shell stratum [goyne's
	4	7428	28	Keys's place, now Walker's
	5	7420	27	Phillips's
	6	7418	26	Road opposite the Glenn place
26	9 a m	7527	30	At a stump below Cascade creek
		7502	30	16 ft. above waved layer, in Bullock's creek and 24 below a second waved layer
	1	7421	29	Top of Bullock's hill
		7421	29	Mound
		7439	29	Top of Botany hill
	4	7507	31	High water mark, Ohio river
	7	7531	27	My own room
				Adams county.
Aug. 8	1 p m	7536	34	Manchester, high water of Ohio
	4	7539		Same place [at E. Bowman's
	5	7525	31	Two miles north of Manchester, in a creek
	6	7464	30	Four miles N of Manchester, flinty lime-st.
9	8 a m	7415	29	At 2d story of Mrs. Wood's, in W. Union

Day.	Hour.	Bar.	Ther. Degs.	Place of observation.
Aug. 9	9 a m	7475	29	Bottom of the hill towards Hillsborough
	11	7478	31	Top of flinty stratum in Lick fork
	3 p m	7415	30	At Mrs. Wood's
		7405	30	Poplar tree, highest ground near W. Union
				West Union to Cave Hill, 4 *miles*.
		7454	29	Bottom of the hill towards Decatur
10	8	7425	28	At Mrs. Wood's
		7419	31	Poplar tree
	9	7427	31	At Mrs. Wood's, again
	12	7401	34	Bald hill top
	3 p m	7393	33.5	Cave hill, James Gibbon's house
		7401	33.5	Gibbon's spring
	5	7386	32	Cave of Cave hill, above the entrance
		7371	32	Top of Cave hill
	5½	7395	30	George Ingell's spring, Bald hill
		7382	30	Top of Bald hill, again
		7407	30	Run at the foot of Bald hill
	6	7416	30	Run near Mullen's
		7429	29	Run within 2 miles of West Union
		7433	28	Run at the bottom of West Union hill
	8	7406	26	At Mrs. Wood's
				West Union to Locust Grove, 17 *miles*.
11	8 a m	7421	30	R. Andrews' spring, 1 mile from W. Union
	9	7460	30	At James Reed's, on top of flinty layer
		7460	31	Top of flinty layer, at Jennings'
		7474	31	Bottom of flinty layer
		7481	32	Top of blue limestone, in Lick fork
	10	7489	34	Waved stratum near Treber's
	1 p m	7499	32	Water of Brush creek, mouth of Lick fork
	3	7495	29	Water at Sample's tavern
12	6	7519	24	Same place
		7518	24	Same place
	7	7501	24	Bottom of flinty stratum near Sample's
		7487	25	Top of same at same place
	9	7459	24	Top of marl, or bottom of cliff
		7437	24	Jacksonville
	1 p m	7466	24	3 miles from Jacksonville, towards Locust Grove
	1	7472	27	Locust Grove tavern
		7476	27	Run below the tavern

Day.	Hour.	Bar.	Ther. Degs.	Place of observation.
				Locust Grove to Rockville, 38 *miles.*
Aug. 12	2 p m	7458		Top of ridge between O. and Scioto to B. cr.
	3	7497	27	First crossing Scioto, Brush creek
13	6	7518	16	Thomas Thompsons, Scioto, Brush creek
	9	7420	27	Top of sandstone knob, 2 m. below Thomp- [son's
	10	7497	27	Bottom of sandstone
		7505	27	Top of slate
		7540	27	Water's edge Scioto, Brush creek
14	6 a m	7533	18	Water's edge of creek at John Williams'
	12	7482	26.5	Top of slate, 4 miles towards Rockville from [J. Williams's
		7423	27	Fucoid impressions
	1 p m	7382	28	At top near Jefferson township line
	2	7479	26	Top of slate, south side of hill
				At Rockville.
	6	7545	29	Mr. Loughery's, high water of the Ohio
15	6 a m	7531	20	Same place
	9	7483	27	Top of slate
		7445	27	"City ledge" at Rockville quarry
	9½	7530	31	Mr. Loughery's house, again.
	10	7485	31	Top of slate, again
	11	7462	30	White stratum
	12	7415	31	Beautiful quarry
	1 p m	7379	33	Top of the hill at Rockville
	1	7390	34	Iron ore stratum
	2	7424	33	City ledge, again
		7503	32	Mr. Loughery's house (showers and wind)
	4	7500	33	High water, Ohio
	4	7446	31	Top slate
	4	7424	31	White ledge
	5	7405	31	City ledge
		7374	31	Iron stratum
		7363	31	Hill top at Rockville
16		7476	24	Mr. Loughery's
	6 a m	7368	23	Iron stratum
		7369	23	Same place
	10	7405	22	City ledge
				Rockville to Coxe's, 4 miles.
	6 p m	7511	22	Low water of Ohio 3½ miles below Rockville
17	7	7519	20	Sulphur lick run

Day.	Hour.	Bar.	Ther. Degs.	Place of observation.
Aug. 17		7513	20	Bottom of slate in same run
		7440	20	Top of slate on Coxe's hill 4 m. below R.
	8 a m	7361	20	Top of Coxe's hill
	9	7440	20	Top of slate again
	10	7523	26	Top of cliff limestone in Sulphur Lick run
		7514	26	Top of clay, or bottom of slate
				Coxe's to mouth of Beasley's fork.
	12	7512	28½	2 m. below Coxe's at Fernier's, high water
	12	7489	28½	Top of cliff at the same place
	1 p m	7497	28½	Bottom of cliff half of a mile below Fer-
		7472	28½	Top of cliff at the same place [nier's
	2	7506	28½	Alex's run, 2 m. above mouth of B. C.
		7513	28	Waters edge Ohio river {mouth
	4	7479	28	Col. McKee's, E. side B. C. 2 m's above its
				John Page's, mouth of Beasley's fork, W. U.
18	6 a m	7462	19	Top of flinty limestone at mouth Beasley's
		7428	20	Bottom of cliff limestone, same place [fork
		7404	20	Top do do do
		7478	20	Bottom of flinty layer, same place
	7	7514	20	School house, high water mark, Ohio
	9	7478	24	Bottom of flinty layer, two m's E. of W. U.
	12	7401	27	At Mrs. Woods in West Union.
				West Union to Marble Furnace, 16 *miles.*
22	9 a m	7508	27	Lick fork, Hillsborough road
		7500	27	A run 2½ miles N. West Union
		7502	28	A 2d run 12 ft. below top of flinty limestone
	11	7495	32	Mr. Findlay's, 7 miles N. West Union
		7500	32	Mr. Findlay's spring
	12	7510	32	Top of blue limestone in Cherry fork
		7514	32	Half a mile down the next branch, N.
	1 p m	7482	33	Samuel Dryden's, 12 miles, Air 93° F.
	3	7534	33	West fork of Brush creek
	4	7438	31	Ridge 15 miles, cliff limestone
	6	7485	28	Fork within 2 miles of Marble Furnace
		7475	28	Upper side of the flinty limestone, well de-
	8	7514	25	At Mr. Sumers's marble furnace [fined
23	6 a m	7510	21	Same place
		7534	21	Water edge, Marble Furnace
	7	7511	21	Top of flinty limestone near Marble do

Day.	Hour.	Bar.	Ther. Deg.	Place of observation.
Aug.23	8 a m	7514	25	Mr. Summers's house again
	9	7526		Mr. Summers's spring. Temp. 54° F.
				Marble Furnace to Locust Grove.
	9 a m	7499	26	Bottom of cliff limestone
		7483	28	Table land over the cliff
	11	7499	31	Locust Grove, Cannon's tavern
				Region of the sulphur springs.
	4 p m	7438	31	Top of Sunken mountain
		7493	32	Massie's sulphur spring
		7485	31	Mershon's spring
	6	7481	26	Locust Grove, Cannon's again
				Detour to Pine Hill, about 2 miles.
24	9 a m	7473	26	Bottom of slate on Pine hill
		7404	26	Top of do do (238 ft. thick)
	10	7395	28	Top of Pine hill, south end
		7380	28	do do north end
	11	7477	27	Bottom of Pine hill in the cliff limestone
	12	7475	27	Locust Grove again
	1 p m	7469	28	Same place
				Locust Grove to Sinking Spring, 6 miles.
		7475	32	Locust Grove at the run or spring
		7468	32	N. bank of the run
	2	7443	32	Pemberton's hill
		7478	32	Fork of crooked creek, N. of Locust Grove
	3	7482	32	Second fork, same creek
		7472	32	Mershon's sulphur spring
	8	7437	27	Copeland's hotel, Sinking springs
				Vicinity of Sinking Spring.
25	7 a m	7477	36.5	Straight creek, water edge
	9	7477	30	Same place
	10	7431	31	Top of hill in road, half m. S. of S. spring
	11	7436	31	At the Sinking spring

Day	Hour.	Bar.	Ther. Degs.	Place of observation.
				Sinking Spring to Fort Hill, 3 miles.
Aug.25	12	7449	33	Water's edge at Shepherd's mill on Brush c.
	2 p m	7411	32	Top of cliff limestone or bottom of slate
	3 p m	7338	31	Top of slate (251.85 feet thick)
		7310	30	Top of the hill in the fort (479 ft. above c.)
	5	7305	28	Same place, (a shower)
	7	7408	28	Copeland's tavern, Sinking Spring
				Re-survey of Fort Hill.
26	6 a m	7441	23.5	Copeland's [Spring
	7	7490	23	At water's edge, Brush cr. half m. from S.
	9	7451	25	Top of limestone or bottom of slate, ft. Hill
	10	7376	25	Top of slate (258.75 feet thick) [S. spring
		7349	25	Top of hill in fort, 486.45 ft. above cr. at
				Fort Hill to West Union.
27	8 a m	7409	22	Mr. West's about 5 ms. westward from Ft.
	9	7455	24	Creek half m. S. of Mr. West's [Hill
	10	7411	30	Top of table land 3 or 4 ms. S. Mr. West's
		7450	30	Flinty stratum on descending from the table
	11	7463	30	Middle fork Brush cr. N. line Adams co.
	3 p m	7410	35	George's cr. top of blue limestone
		7460	35	West fork of Brush creek
				West Union to Brush Creek Forge, 5 miles.
Sept. 1	12 a m	7390	21	West Union, Mrs. Wood's
	2 p m	7399	26	3 miles east of West Union, on a ridge
	3	7475	27	Top of flinty limestone on descending to Grooms's mill
	4	7502	26	Soldier's run near the mill below Grooms's
	4½	7511	26	At Mr. Fisher's, high water of the Ohio
				Ascent of Split Rock Hill.
2	7 a m	7552	14	At Mr. Fisher's
	8	7473	13	Bottom of cliff
		7456	10.5	Bottom of Split rock
		7441	10.5	Top of do
		7430	16	Top of hill
		7486	17	Bottom of cliff near Hazelett's
	12	7526	19	Top of flinty layer near John Hazelett's

Day.	Hour.	Bar.	Ther. Degs.	Place of observation.
Sept. 2	12 a m	7553	20	Top of blue limestone
		7557	20	At Mr. Fisher's again, high water of Ohio
				Forge to West Union, via Gift Ridge.
2	1 p m	7558	23	School-house on Beasley's fork [ridge
	2	7528	24	Top of blue limestone in ascending Gift
		7501	23	Top of flinty do do do
		7434	27	Samuel Naylor's on Gift ridge
	3	7425	25	Hill within 4 miles of Manchester
	4	7432	25	Near a mound and school-house [chester
		7477	24	Top of flinty limestone within 2 ms. of Man-
	5	7437	24	Bottom of the cliff at the same place
	8	7436	20	At West Union, Mrs. Wood's
3	a m	7442	14	At Mrs. Wood's
		7473		Bottom of cliff at Darlington's quarry
				West Union to Cincinnati, via Winchester.
4	7 a m	7455	14	At West Union, Mrs. Wood's
	10	7465	25	Top of West Union hill near poplar tree
		7511	25	Bottom of W. Union hill towards Bald hill
	12	7429	26	Top of Cave hill
		7444	26	Surface at the cave
		7449	26	Bottom of cliff limestone near the cave
		7485	26	Limestone in run at the bottom of the hill
	2 p m	7499	29	Cherry fork, Thompson's mill
		7475	29	Run within a mile of Winchester
	4	7458	28	Winchester
5	5 a m	7460	17	Russelville
		7578		Cluff's creek near a waved layer.